Classification of the Sandhill and Sand Plain Plant Communities of the Wainwright Dunes Ecological Reserve

Prepared For:

Resource Data Branch
Alberta Sustainable Resource Development
Edmonton, Alberta

Prepared By:

Geowest Environmental Consultants Ltd.

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GEOWEST
ENVIRONMENTAL CONSULTANTS LTD.

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Resource Data Branch
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Executive Summary

The Resource Data Division of Alberta Sustainable Resource Development contracted Geowest Environmental Consultants Ltd. to produce a classification of sand dune and sand plain plant community types within the Wainwright Dunes Ecological Reserve, an area found in the Parkland Natural Region of Alberta. This initiative is in support of the Alberta Natural Heritage Information Centre (ANHIC). ANHIC collects, evaluates and makes available data on elements of natural biodiversity in Alberta, including flora, fauna and native plant communities. ANHIC develops tracking lists of elements that are considered of high priority because they are considered rare or special in some way. ANHIC's long-term goal is to develop a list of plant community types that occur throughout the province and to attempt to identify community types that require conservation initiatives.

The Wainwright Dunes Ecological Reserve is located directly south of Canadian Forces Base (CFB) Wainwright, comprising an area of just over 2,800 hectares. The Wainwright Dunes Ecological Reserve is provincial Crown land, administered by Alberta Community Development. Current land uses consist primarily of cattle grazing on native pasture. The Buffalo Park Grazing Association holds the lease for grazing rights within and adjacent to the Ecological Reserve.

The objectives of this project are:

- to develop a plant community classification of sand dune and sand plain plant communities of the Wainwright Dunes Ecological Reserve, representative of the Central Parkland Natural Subregion based on field survey, correlations with other surveys and any available previously-collected data
- evaluate and assign a preliminary provincial conservation rank to each identified community type, based on its rarity/endemism or threats to its condition.

This was accomplished by developing a sampling protocol and subsequently collecting field data on plant communities of the sand dune and sand plain landscapes of the Wainwright Dunes Ecological Reserve. Furthermore, a comparison of defined plant community types to similar types described in previously conducted field surveys in similar landscapes in Alberta and adjacent provinces and states was completed. A similarity rating based on a scale provided by Corns (1983) is also provided.

This classification will provide a better understanding of plant community biodiversity in Alberta and will contribute to the development of a Canadian National Vegetation Classification (CNVC), the Canadian component of the International Classification of Ecological Communities (ICEC). The ICEC system has been adopted by the United States and it is a national standard for vegetation classification known as the U.S. National Vegetation Classification (USNVC).

An extensive literature search was completed, to locate references relating to aspen parkland sand dune and sand plain plant communities. Literature from other jurisdictions was also obtained, primarily for Saskatchewan, Manitoba, Montana, Idaho, Wyoming, North and South Dakota, Nebraska and Minnesota.

Field sampling occurred between July 14th and August 1st, 2002 following a review of the sampling strategy with Alberta Sustainable Resource Development staff. In total 40 sampling plots were established, distributed throughout a range of community types and topographic positions. Survey sites were selected based on an initial review of the survey area, using aerial photographs and vegetation trends observed in the field.

Cluster and ordination analyses were performed on the field data resulting in 12 community types based on the hierarchical guidelines documented in the *International Classification of Ecological Communities: Terrestrial Vegetation of the United States: Volume 1 – The National Classification System: Development, Status and Application* (Grossman *et al.* 1998). Table I documents the names of the community types identified.

Table I. Sand dune and sand plain plant communities in the Wainwright Dunes Ecological Reserve.

Community Type Name	Preliminary Conservation Ranking
Betula occidentalis / Arctostaphylos uva-ursi – Juniperus horizontalis Water birch / common bearberry – creeping juniper	S2S3
Calamovilfa longifolia – Sporobolus cryptandrus – Carex siccata Sand grass – sand dropseed – hay sedge	S2S3
Elaeagnus commutata – Prunus virginiana / Carex siccata – Koeleria macrantha Silverberry – chokecherry / hay sedge – june grass	S2?
Juniperus horizontalis / Stipa comata – Carex siccata Creeping juniper / needle-and-thread – hay sedge	S3S4
Juniperus horizontalis / Calamovilfa longifolia – Carex pensylvanica ssp. heliophila Creeping juniper / sand grass – sun-loving sedge	S3?
Populus balsamifera / Corylus cornuta – Cornus stolonifera / Aralia nudicaulis Balsam poplar / beaked hazelnut – red-osier dogwood / wild sarsaparilla	S5
Populus tremuloides / Juniperus horizontalis / Carex siccata Aspen / creeping juniper / hay sedge	S2S3
Populus tremuloides / Prunus virginiana – Amelanchier alnifolia / Carex siccata Aspen / chokecherry – saskatoon / hay sedge	S3
Populus tremuloides / Amelanchier alnifolia – Rosa acicularis / Poa palustris Aspen / saskatoon – prickly rose / fowl bluegrass	S5
Salix bebbiana / Festuca saximontana Beaked willow / Rocky Mountain sedge	SU
Salix petiolaris / Calamagrostis canadensis Basket willow / bluejoint	SU
Stipa comata – Artemisia frigida – Selaginella densa Needle-and-thread – pasture sagewort – prairie selaginella	S3S4

Each community type identified from the analysis of the plot data was compared against floristically similar community types described for Alberta and other jurisdictions. A summary of the findings are provided as correlation tables, which compare the Wainwright Dunes community types against community types described in literature based on Alberta and other jurisdictions, respectively. A similarity rating between the community types, based on Corns (1983) and recently applied by Strong (2002), was also provided in the tables. A discussion of the community types and associated literature was also provided.

All proposed community types were assigned a preliminary provincial ranking and knowledge gaps were identified. The information in this report can be used to update the community-tracking list by including new community types. Finally, this report can also be used to decide which community types require further studies and to prioritize these studies.

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Acknowledgements

We wish to thank Keith Ainsley (Resource Data Division – Alberta Sustainable Resource Development), and Lorna Allen and Ksenija Vujnovic (Alberta Natural Heritage Information Centre – Alberta Community Development) for assistance throughout this project. Harry Loonen and Patrick J. Porter of Alberta Sustainable Resource Development in Wainwright were also valuable information sources on the Wainwright Dunes Ecological Reserve and provided many important references. The services of Kathy Tannas are also greatly appreciated for identification and verification of plant species. We are also grateful to Ruth Bonneville, Natalie Tashe and Dennis O'Leary for assistance with fieldwork, as well as Terry Lang (Geowest Environmental Consultants Ltd.) who contributed to the successful completion of this project.

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1.0 Introduction

1.1 Project Purpose and Objectives

The Resource Data Division of Alberta Sustainable Resource Development retained Geowest Environmental Consultants Ltd. to produce a classification of sand dune and sand plain plant community types for the Wainwright Dunes Ecological Reserve, in the Central Parkland Natural Subregion of Alberta. This initiative is in support of the Alberta Natural Heritage Information Centre (ANHIC). ANHIC collects, evaluates and makes available data on elements of natural biodiversity in Alberta, including flora, fauna and native plant communities. ANHIC develops tracking lists of elements that are considered of high priority because they are rare or special in some way. ANHIC's long-term goal is to develop a list of plant community types that occur throughout the province and to attempt to identify community types that require conservation initiatives.

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This classification will provide a better understanding of plant community biodiversity in Alberta and will contribute to the development of a Canadian National Vegetation Classification (CNVC), the Canadian component of the International Classification of Ecological Communities (ICEC). The ICEC system has been adopted by the United States and it is a national standard for vegetation classification known as the U.S. National Vegetation Classification (USNVC).

1.2 Study Area Description

1.2.1 Disposition and Land-Use

The Wainwright Dunes Ecological Reserve is located directly south of Canadian Forces Base (CFB) Wainwright, including the following sections of land:

- Township 42, Range 5, West of the 4th Meridian, sections 2, 3, 4, 5, 9, 10, 11, 14, 15 and 16
- Township 41, Range 5, West of the 4th Meridian, sections 33 and 34.

The Wainwright Dunes Ecological Reserve is provincial Crown land, administered by Alberta Community Development. The total area comprises just over 2,800 hectares. Current land uses consist primarily of cattle grazing on native pasture. One grazing association holds the lease for grazing rights within and adjacent to the Ecological Reserve.

1.2.1 Climate, landforms and topography

The Wainwright Dunes Ecological Reserve is situated in the Central Parkland Natural Subregion (Achuff 1994) and is representative of the aspen parkland as well as sand dune and sand plain ecosystems of this subregion. The climate of the Central Parkland is somewhat transitional between the Boreal regions to the north and the grasslands to the south. The Central Parkland is somewhat different from the grasslands in that the majority of summer precipitation is received in July, instead of June (Strong and Leggat 1992). A summary of general climatic data is provided in Table 1.

Table 1.

Table 1.Summary of climatic data for the Central Parkland Natural Subregion (adapted from Achuff 1994 and Strong 1992).

Mean Annual Temperature	2°C
Mean Summer Temperature	13°C
Mean Winter Temperature	-9°C
Total Annual Precipitation	350-450mm

The majority of the surficial materials in the Ecological Reserve were deposited by glacial meltwaters, which were later subjected to strong northwesterly winds. Consequently, a large complex of aeolian dunes were formed. The dunes are closely aligned in parallel ridges oriented in a northwest to southeast direction. Originally Bayrock (1958) described these dunes as longitudinal. However, they are now considered to be sand ridges of the 'North Battleford' type, formed by the transverse deflation of the southwestern wing of parabolic dunes. Ultimately, an elongate series of ridges with a somewhat sinuous crest line were formed, characterized by a strongly asymmetrical transverse profile (David 1977; Fehr 1984). Some of the dunes are steeply sided and can be up to 30 metres in height. Active blowouts are can be found scattered through the dune system (Cottonwood Consultants 1986).

Generally level sandy areas, known as outwash plains, occur along the northern and western regions and around David Lake. Outwash along the northern boundary may have been reworked by wind, giving it more topographic relief than the level outwash plains along the Ribstone Creek valley and around David Lake.

Elevations range from approximately 720 metres in the northeast corner of the reserve to 657 metres at David Lake, a difference of 63 metres.

2.0 Methods

2.1 Literature Search

An extensive literature search was completed to locate references relating to sand dune and sand plain plant communities in Alberta. Literature related to other jurisdictions was also obtained, primarily for Saskatchewan, Manitoba, Montana, Idaho, Wyoming, North and South Dakota, Nebraska and Minnesota. Lorna Allen, of Alberta Community Development, and Harry Loonen and Patrick J. Porter of Alberta Sustainable Resource Development in Wainwright also provided many references.

2.2 Field Sampling

Field sampling occurred between July 14th and August 1st 2002 following a review of the sampling strategy with Alberta Sustainable Resource Development staff. In total 40 sampling plots were established, distributed throughout a range of community types and topographic positions. Survey sites were selected based on an initial review of biophysical inventories for the survey area, as well as using aerial photographs and vegetation trends observed in the field. In most instances, a minimum of three to five plots were established in each observed community type.

Alberta Sustainable Resource Development provided guidelines for distributing and establishing sampling plots. As such, sampling plots were distributed based on the following criteria:

- one sampling plot was required to document communities considered equivalent to those identified in previous work;
- five sampling plots were required to represent major communities that were poorly correlated with those identified in previous work; and
- three sampling plots were considered to be adequate when representing poorly correlated minor community types that occurred infrequently in the landscape.

Community types that were represented by fewer than three sampling plots were to be qualitatively described but considered tentative pending future data collection. As such, sampling plots were placed quite subjectively in sites considered to be 'communities.'

Vegetation and site description forms (RDB 2002-3 and RDB 2002-1 respectively) were completed at each site. The forms were completed using definitions and guidelines from Alberta Sustainable Resource Development (2003). Percent cover of vascular plant species was visually estimated in each plot, using the relevé method. All dominant, codominant and diagnostic species were recorded. Each unknown species encountered was collected for expert identification.

Plots were documented with a 35mm or digital photograph to characterize the structure and composition of the plant community. The location of each survey site was determined using a Trimble GeoExplorer III unit and the locations were recorded on the site description forms. Furthermore, the location of each plot was marked on the aerial photographs. Each plot was located with a pinprick and circled and annotated on the back of the aerial photograph.

2.3 Plant Identification Verification

Any unknown species encountered were labeled and collected. Kathy Tannas, of Eastern Slopes Rangeland Seeds, verified these specimens. The plot forms and digital database were updated, to reflect Ms. Tannas' findings.

2.4 Vegetation Data Analysis and Classification

Vegetation data were entered into an Excel spreadsheet, comprising a matrix of field plot versus plant species abundance. The final database contained 40 plots and 105 species columns. The field data spreadsheet was then imported into PC ORD version 4.20, for classification analysis.

Cluster Analysis

The vegetation classification incorporated all stages of plant succession and was not restricted to potential or predicted climax associations, following Braun-Blanquet (1965). Cluster analysis was used to allow for a more objective classification of sand dune and sand plain communities based on species composition. A hierarchical, agglomerative clustering technique (Farthest Neighbour Analysis) was used to help identify plant community types. This clustering method progressively combines plots/samples from an individual based on their similarity until all samples are in one group (similarity analysis).

Several clustering options available in PC ORD v.4.20 were explored and the group linkage method with the lowest percent chaining (maximum information) was selected for analysis (Farthest Neighbor). The Bray-Curtis (Sorensen) and Relative Sorensen distance measures were investigated and in combination with the Farthest Neighbor group linkage method, the Relative Sorenson distance measure provided the lowest percent chaining value. Other distance measures were explored (Euclidean, Relative Euclidean), however, these measures had higher percent chaining values and seemed to introduce confusion into the clustering results.

Detrended Correspondence Analysis

Detrended correspondence analysis was also investigated to help identify plant community types. Detrended correspondence analysis (DCA) is an indirect gradient analysis/ordination technique that ordinates both species and samples (plots) concurrently (Hill and Gauch 1980). Indirect gradient analysis/ordination obtains axes characterizing major trends of environmental and community variation from calculations based on the sample data (Whittaker 1978). Conversely, direct gradient analysis (DGA) relates species directly to measured environmental factors. DCA therefore does not include analysis of environmental factors (indirect analysis), however, this data is used to help interpret and explain the results.

DCA is based on reciprocal averaging (RA) or correspondence analysis (CA). Its main advantage is that through the detrending process, an 'arch' effect is eliminated that commonly distorts the results of RA and CA. PC-ORD offers several options prior to running the ordination:

- Down-weighting rare species and
- Rescaling of axes.

By down-weighting rare species in DCA, the abundances of species rarer than

Fmax/5

(where Fmax is the frequency of the most common species)

are down weighted in a relative amount to their frequency. Species that are more common than Fmax/5 are not down weighted (McCune and Mefford 1999). This option was selected for the analysis to capture the influence of less prevalent species in the sandhills plant community composition without overly distorting the results.

Another option presented in DCA is the rescaling of axes. Another drawback to CA (aside from the arch effect) is that the axis extremes can be condensed. In particular the distances between samples along an axis may not reflect the actual variation in species composition. This compression of the ends of the gradients is corrected in DCA by *non-linear rescaling*. The non-linear rescaling is based on the average standard deviation of species turnover and follows the original version of DECORANA in multiplying the standard deviations by 100 and shifting the scales such that all scores are positive (McCune and Mefford 1999). This option was selected, using the default values in PCORD v.4.20 to eliminate the compression of species/samples at the extremes of axes.

2.5 Taxonomic Considerations

Plant scientific names used in this report follow Moss (1983) and Alberta Environmental Protection (1993). However, there is a discrepancy between these references and those used for the classification of ecological communities used by NatureServe, which follows *A synonymized checklist and atlas with biological attributes for the vascular flora of the United States, Canada* and *Greenland* (Kartesz 1999). A summary of the discrepancies is provided in Table 2.

Table 2. Synonymy of plant species for the Wainwright Dunes Ecological Reserve.

Alberta Environmental Protection (1993)	Kartesz (1999) / NatureServe (2003)	Common Name
Stipa comata	*Hesperostipa comata*	needle-and-thread
Carex pensylvanica ssp. heliophila	*Carex inops ssp. heliophila*	sun-loving sedge
Cornus stolonifera	*Cornus sericea*	red-osier dogwood

The primary concern regarding the use of synonymous species names, is when searching NatureServe for ecological communities, using scientific plant names other than those of Kartesz (1999) will yield false results. For example, searching for *Stipa comata* within ecological communities will return no similar plant community types. However, searching for *Hesperostipa comata* will return numerous related alliances and associations.

Furthermore, no attempt to standardize species and community names was made when referencing other literature. Many recent reports from the United States describe community types using Kartesz (1999) as the taxonomic reference. As such, community names described in this report may not be completely synonymous with those stated in the literature, although they are referring to the same species. A glossary relating scientific and common plant species names is provided in Appendix 1.

2.6 Cross-referencing of Proposed Community Types to Literature

Based on the review of existing literature and the development of a preliminary classification of sandhill community types, two cross-reference tables were developed. The first table cross-referenced proposed community types with similar community types previously described for Alberta. The second table cross-referenced proposed community types with similar community types identified in other jurisdictions, including Saskatchewan, Manitoba, Montana, Idaho, Wyoming, North and South Dakota, Nebraska and Minnesota. In both tables, the proposed community types are also given a similarity rating to the previously identified community types, based on a scale provided by Corns (1983) and also recently used by Coenen and Bentz (2003) and Strong (2002). The tables facilitated the identification of similar types as well as the identification of information gaps.

2.7 Community Classification System

Community classification for the sand dune and sand plains plant communities within the Wainwright Dunes Ecological Reserve followed the hierarchical guidelines documented in the *International Classification of Ecological Communities: Terrestrial Vegetation of the United States: Volume 1 – The National Classification System: Development, Status and Application* (Grossman *et al.* 1998). The classification system outlined in this publication organizes terrestrial vegetation into five physiognomic and two floristic levels, as shown in Table 3.

Table 3. Hierarchical levels and definitions for the ICEC terrestrial vegetation classification system, adapted from (Grossman et al. 1998).

	Hierarchical Level	Definition	Levels or Examples
Physiognomic Levels	**Formation Class**	Formation class is defined based on the vegetation structure of the dominant, uppermost life form	1. Forest/Woodland: Trees with crowns overlapping (25-99% cover) 2. Shrubland: Shrubs generally >0.5 m height forming >25% cover. 3. Dwarf-Shrubland: Shrubs <0.5 m height forming >25% cover. 4. Herbaceous: Graminoids, ferns and forbs dominant. 5. Non-vascular: Bryophytes, lichens and algae dominant. 6. Sparse: Abiotic substrate dominant
	Formation Subclass	Subclass is based on the growth-form characteristics of the dominant life form, predominantly leaf phenology	Evergreen, deciduous, mixed-deciduous for Forest/Woodland, Shrubland and Dwarf-Shrubland Classes. Perennial and Annual for the Herbaceous class. Substrate characteristics (e.g. rock, sand, cobbles, etc.) are used for the Sparse vegetation class.
	Formation Group	Group is defined based on leaf characters, the presence of a woody stratum or topographic position.	Broad leaf or needle leaf used for Forest/Woodland, Shrubland and Dwarf-Shrubland classes. Presence of a woody stratum separates groups in Herbaceous and Non-vascular classes. Sparse vegetation communities are separated based on topographic position (e.g. shore, cliffs, dunes, etc).
	Formation Subgroup	Subgroup is defined based on the level of anthropogenic disturbance.	All groups divide each community type into a Natural/Near Natural, Semi-Natural or Planted/Cultivated subgroup.
	Formation	Formations represent vegetation types that share a definite physiognomy or structure within broadly defined environmental factors, landscape positions or hydrological regimes.	e.g. Temperate or sub-polar deciduous shrubland
Floristic Levels	**Alliance**	Alliance is a physiognomically uniform groups of plant associations sharing one or more diagnostic species, which as a rule are found in the uppermost stratum of the vegetation	e.g. *Populus tremuloides – Picea glauca / Linnea borealis* Forest Alliance e.g. *Carex utriculata* Herbaceous Alliance
	Association	Association is the lowest level of the hierarchy and is defined as a plant community type of definite floristic composition, uniform habitat conditions and uniform physiognomy.	Nomenclature is based on the diagnostic species. Species occurring in the uppermost stratum are listed first (separated by a hyphen if in the same stratum or a slash if in a different strata) followed successively by those occurring in lower levels. Within the same stratum, the order of species names generally reflects decreasing levels of dominance or constancy.

2.8 *Evaluation and Assignment of Preliminary Provincial Ranking*

Each community type was evaluated and assigned a preliminary provincial ranking. The ranking system used is based on The Nature Conservancy's species ranking system (Grossman *et al.* 1994), as used by ANHIC (Allen 2003). The two primary criteria for developing community ranks are the total number of occurrences and the total area of each community, range-wide. Measures of geographic range, trends in status and immediate threats to the community's persistence are also considered in ranking. Preliminary ranks range from S1 (rare) to S5 (wide-spread) and are defined in Table 4.

Table 4. Provincial conservation ranks and definitions (adapted from Allen 2003).

Preliminary Rank*	Criteria
G1(S1)	Five or fewer occurrences or very few remaining hectares
G2(S2)	Six to 20 occurrences or few remaining hectares
G3(S3)	21 to 100 occurrences. May be rare and local throughout its range or found locally, even abundantly, in a restricted range (e.g. a single western province or physiographic region in the East)
G4(S4)	Apparently secure globally (State / Province wide), though it may be quite rare in parts of its range, especially at the periphery.
G5(S5)	Demonstrably secure globally (State / Province wide) thought it might be quite rare in parts of its range, especially at the periphery.
GU(SU)	Status is uncertain
GH(SH)	Historic. Presumed eliminated in the province with little or no likelihood that it will be rediscovered. There may be the potential for restoration.
GX(SX)	Believed to be eliminated throughout its range, with virtually no likelihood that it will be rediscovered (e.g. American Chestnut Forest)
GP(SP)	Potentially exists. Further documentation needed.
G?(S?)	Element is not yet ranked.
MODIFIERS	
Q	Can be added to any global rank to denote questionable taxonomy (e.g. G2Q= 6 to 20 known occurrences but questions exist concerning the classification of this type)
?	Can be added to any rank to denote an inexact numeric rank (e.g. G1? = Believed to be 5 or less occurrences but some doubt still exists concerning status).

*Ranks can be combined to indicate a range (e.g. G2G3 = May be between 6 to 100 occurrences throughout range but the exact status is uncertain). Combined ranks indicate a larger margin of error than ranks assigned a "?" qualifier.

3.0 Results and Discussion

3.1 Vegetation Data Analysis and Classification

Results from the agglomerative clustering methods were examined to determine the ecological meaning of the clusters and interpret the community types (Figure 1). Examination of the resulting dendrogram revealed numerous small groups. Several community types were consistently clustered together, particularly:

- Plots with high *Salix petiolaris* cover (plots 12, 20 and 39)
- Plots with high *Elaeagnus commutata* cover (plots 24, 31 and 33)
- Plots with high *Populus balsamifera* cover (plots 4 and 5)

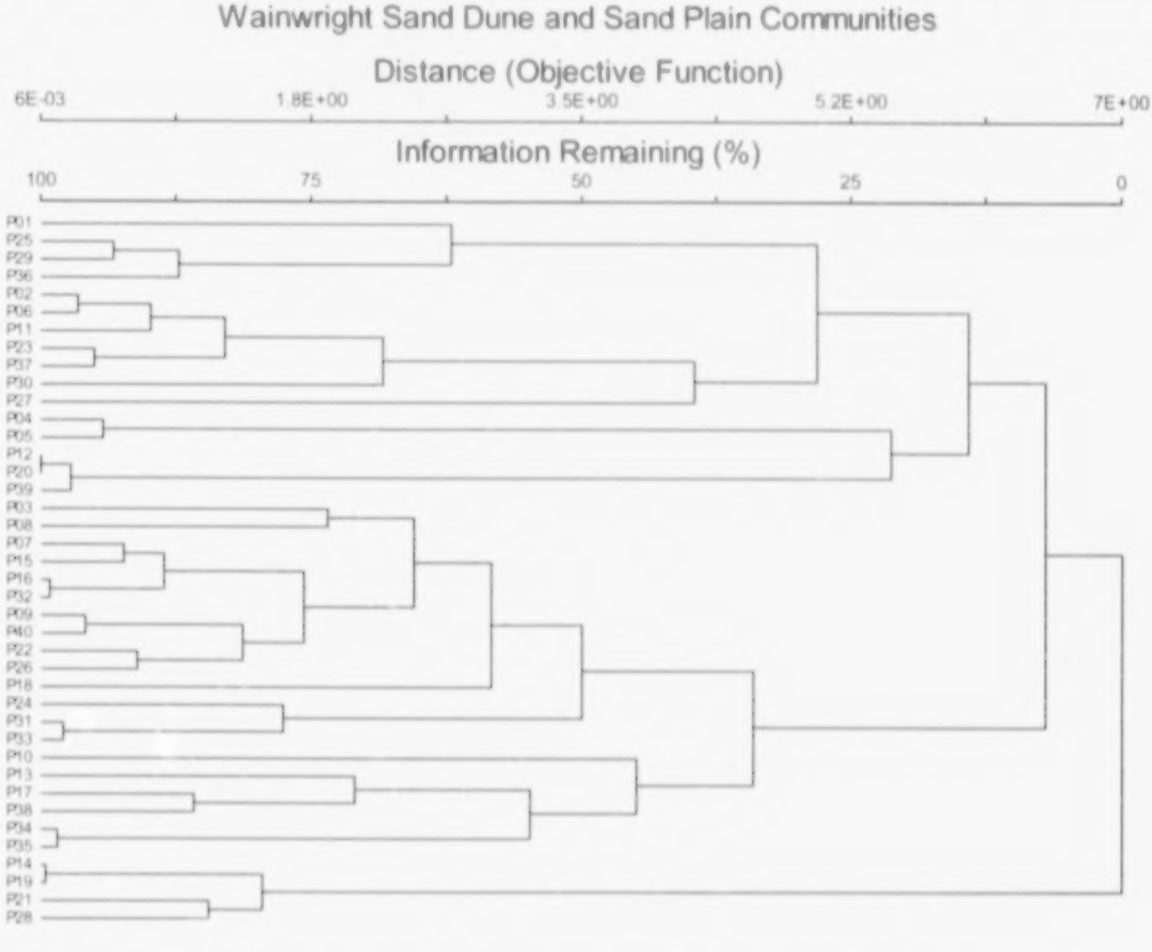

Figure 1. Cluster analysis of 40 plots collected July – August 2003. Linkage method: Farthest Neighbour. Distance Measure: Relative Sorensen (Kulcynski). Percent Chaining=7.46%.

However, other community types, particularly aspen-dominated or grassland communities could not be easily discerned based on the cluster analysis alone.

Detrended correspondence analysis (DCA) helped to group plots with similar species compositions and also confirmed some of the community types observed from the grouping of plots in the cluster analysis. Approximately 12 groups were recognized based on the ordination of plots and species, with several 'groups' comprising only one or two sample plots as shown in Figure 2 and Figure 3. Output from the PC-ORD DCA is provided in Appendix 2.

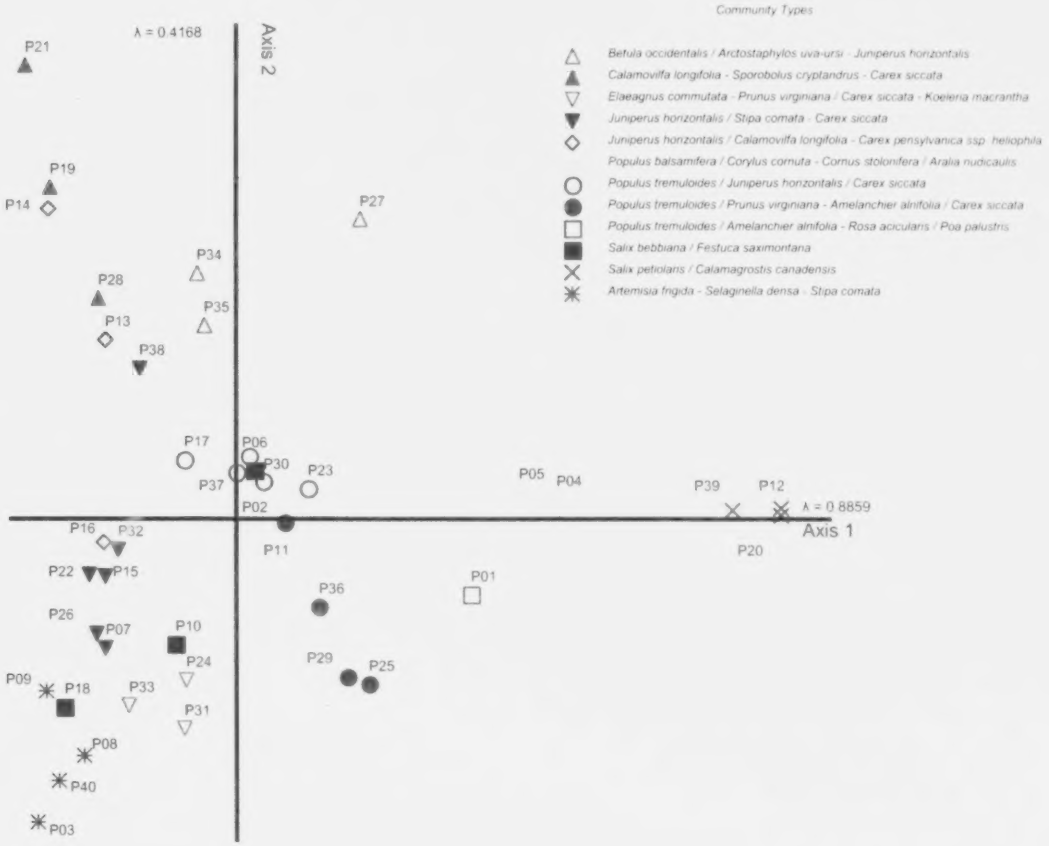

Figure 2. Ordination diagram based on Detrended Correspondence Analysis (DCA) of 40 plots collected in July – August 2003. Total variance in the species data (inertia) 5.3428. Eigenvector 1 = 0.8859 or 16.6% of the total variance in the species data. Eigenvector 2 = 0.4168 or 7.8% of the total variance in the species data.

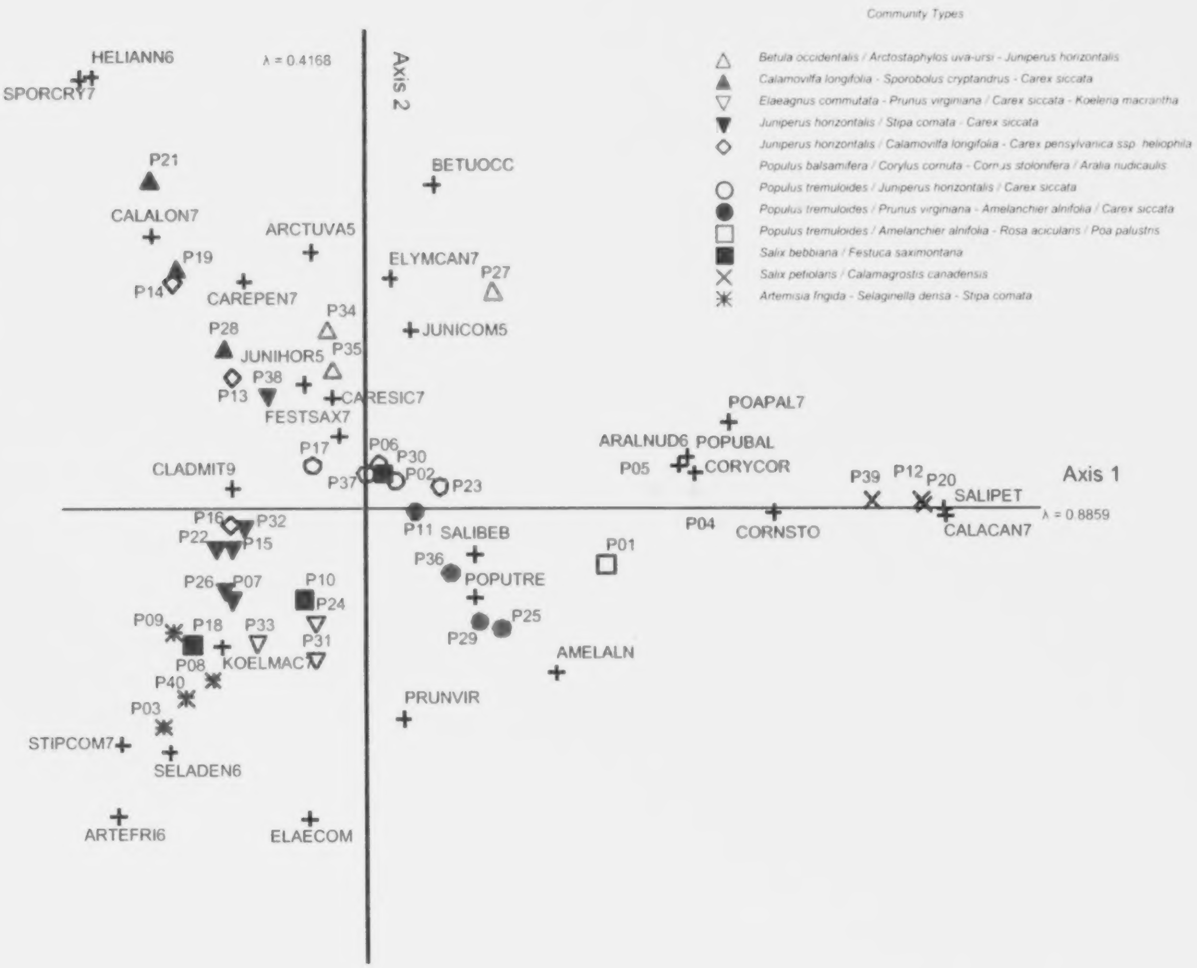

Figure 3. Biplot based on Detrended Correspondence Analysis (DCA) of sample plots (40) and plant species (105) collected at the Wainwright Dunes Ecological Reserve in July-August 2003.

Data were summarized for the resulting community types, including mean percent cover of plant species and surface substrates, standard deviation and standard error and species prominence. Species prominence was calculated using the following formula:

$$\text{mean \% cover} \times \sqrt{\text{\% presence}}$$

A summary of site data is also provided.

3.2 Preliminary Classification of Community Types

A total of 12 plant communities (associations) were found to occur in the Wainwright Dunes Ecological Reserve sand dune and sand plains areas. Community types included all classes, except sparsely vegetated and non-vascular and are presented in Table 5 by major physiognomic level.

Table 5. Sandhill and sand plain plant community types (associations) found in the Wainwright Dunes Ecological Reserve.

Terrestrial	**Associations**
Forest/Woodland	
Deciduous Forest/Woodland	
Cold Deciduous Forest/Woodland	
Natural / Near Natural	
Temperate or subpolar cold deciduous forest/woodland	
Populus tremuloides Forest/Woodland Alliance	*Populus tremuloides / Juniperus horizontalis / Carex siccata*
	Populus tremuloides / Prunus virginiana - Amelanchier alnifolia / Carex siccata
	Populus tremuloides / Amelanchier alnifolia - Rosa acicularis / Poa palustris
Populus balsamifera Forest/Woodland Alliance	*Populus balsamifera / Corylus cornuta - Cornus stolonifera / Aralia nudicaulis*
Shrubland	
Deciduous Shrubland	
Cold Deciduous Shrubland	
Natural / Near Natural	
Temperate cold deciduous shrubland	
Betula occidentalis Shrubland Alliance	*Betula occidentalis / Arctostaphylos uva-ursi - Juniperus horizontalis*
Elaeagnus commutata Shrubland Alliance	*Elaeagnus commutata - Prunus virginiana / Carex siccata - Koeleria macrantha*
Salix bebbiana Shrubland Alliance	*Salix bebbiana / Festuca saximontana*
Temporarily flooded shrubland	
Salix petiolaris Shrubland Alliance	*Salix petiolaris / Calamagrostis canadensis*
Dwarf Shrubland	
Evergreen Dwarf Shrubland	
Needle-leaved or microphyllous evergreen dwarf-shrubland	
Natural / Near Natural	
Creeping or matted needle-leaved or microphyllous evergreen dwarf-shrubland	
Juniperus horizontalis Dwarf-Shrubland Alliance	*Juniperus horizontalis / Stipa comata - Carex siccata*
	Juniperus horizontalis / Calamovilfa longifolia - Carex pensylvanica ssp. heliophila
Herbaceous Vegetation	
Perennial Graminoid Vegetation	
Temperate or sub-polar grasslands	
Natural / Near Natural	
Medium-tall bunch temperate or sub-polar grasslands	
Stipa comata Bunch Herbaceous Alliance	*Artemisia frigida - Selaginella densa / Stipa comata*
Herbaceous Vegetation	
Perennial Graminoid Vegetation	
Temperate or sub-polar grasslands	
Natural / Near Natural	
Tall sod temperate or sub-polar grasslands	
Calamovilfa longifolia Herbaceous Alliance	*Calamovilfa longifolia - Sporobolus cryptandrus - Carex siccata*

3.2.1 Description of Community Types

Summaries of the 12 sand dune and sand plain community types (associations) found in the Wainwright Dunes Ecological Reserves are provided in the following sections. Representative photos for each community type are provided as Plates 1 – 12. A full listing of species codes is provided in Appendix 2.

Furthermore, each community type identified from the analysis of the plot data was compared against similar community types described for Alberta and other jurisdictions. Tables compare the plant community types of the Wainwright Dunes Ecological Reserve against community types described in literature from Alberta and other jurisdictions. The degree is similarity is also rated, based on a scale developed by Corns (1983) and recently applied by Coenen and Bentz (2003) and Strong (2002). Table 6 summarizes the similarity ratings from Corns (1983).

Table 6.Plant community similarity ratings adapted from Corns (1983).

Rating	Description
1	Identical to or very similar
2	Similar in most respects
3	Several similarities but important differences

The amount and quality of available data used to describe the proposed sand dune and sand plain community types and assign provincial rankings differed from community to community. Furthermore, mapping of community types was not a component of this project. As such, there is no spatial context to provide an estimate of how much area each community type covers. Consequently, some community types were difficult to rank due to deficient or incomplete data and a lack of spatial context. For those communities that are ranked, more information is required to confirm the proposed rank.

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3.3 *Betula occidentalis / Arctostaphylos uva-ursi - Juniperus horizontalis* Association

Water birch / common bearberry – creeping juniper

Plate 1. *Betula occidentalis / Arctostaphylos uva-ursi – Juniperus horizontalis* community type (Water birch / common bearberry – creeping juniper) Plot 34.

This shrubland community was dominated by *Betula occidentalis* in the tall shrub layer and dwarf shrub species including *Arctostaphylos uva-ursi* and *Juniperus horizontalis* in the low shrub layer. Shrub species such as *Spirea alba, Juniperus communis, Salix bebbiana,* and shrubby *Populus tremuloides* were also generally present, although typically with less than 5 % cover. Forb cover was typically low, with *Heterotheca villosa, Artemisia campestris* and *Solidago missouriensis* common forb species. *Carex siccata* was prominent at two of the three plots surveyed, with a mean cover of 15 %. *Calamovilfa longifolia* and *Carex pensylvanica* ssp. *heliophila* were commonly present with low covers. Table 7 summarizes the species composition, mean percent cover, standard error and species prominence for this community type.

Table 7.Summary statistics for the *Betula occidentalis / Arctostaphylos uva-ursi – Juniperus horizontalis* community type (n = 3).

Species	Mean % Cover	Standard Error	Presence	Prominence
Betula occidentalis	36.0	6.0	3	41.6
Carex siccata	15.0	7.6	2	21.2
Arctostaphylos uva-ursi	17.3	9.6	3	20.0
Cladina mitis	11.7	6.0	2	16.5
Juniperus horizontalis	11.0	4.9	3	12.7
Juncus balticus	3.3	3.3	1	6.7
Poa pratensis	3.3	3.3	1	6.7
Populus tremuloides	3.7	2.0	2	5.2
Oryzopsis asperifolia	2.3	2.3	1	4.7
Poa palustris	2.3	2.3	1	4.7
Calamovilfa longifolia	3.0	2.1	2	4.2
Festuca saximontana	2.0	2.0	1	4.0
Schizachne purpurescens	1.7	1.7	1	3.3
Carex pensylvanica ssp heliophila	2.3	1.5	2	3.3
Juniperus communis	2.3	1.5	2	3.3
Spirea alba	2.8	1.6	3	3.3

Species	Mean % Cover	Standard Error	Presence	Prominence
Salix bebbiana	2.0	1.5	2	2.8
Solidago spathulata	1.3	0.7	2	1.9
Heterotheca villosa	1.0	0.6	2	1.4
Carex spp.	0.7	0.7	1	1.3
Epilobium angustifolium	0.7	0.7	1	1.3
Koeleria macrantha	0.7	0.7	1	1.3
Artemisia campestris	0.7	0.3	2	0.9
Cladonia uncialis	0.3	0.3	1	0.7
Fragaria virginiana	0.3	0.3	1	0.7
Ribes oxyacanthoides	0.3	0.3	1	0.7
Rosa acicularis	0.3	0.3	1	0.7
Solidago candensis	0.3	0.3	1	0.7
Lathyrus ochroleucus	0.3	0.2	2	0.5
Chenopodium leptophyllum	0.2	0.2	1	0.3
Equisetum hymenale	0.2	0.2	1	0.3
Erysimum asperum	0.2	0.2	1	0.3
Viola adunca	0.2	0.2	1	0.3

This community was limited in aerial extent, primarily found in the east-central portions of the Ecological Reserve. It was typically found in low-lying, depressional sites between large, widely distributed sand dunes. Soils were sandy, with approximately 50 % low shrub and herbaceous vegetative cover. A summary of site data is provided in Table 8.

Table 8. Summary of site data for the *Betula occidentalis / Arctostaphylos uva-ursi – Juniperus horizontalis* community type (n = 3).

Plot	Elevation	Slope	Aspect	Drainage	Site Position	Surface Shape	Moisture Regime	Nutrient Regime
27	682	0	n/a	Imperfectly	Depression	Concave	Mesic	Rich
34	683	0	n/a	Well	Depression	Concave	Subxeric	Medium
35	688	0	n/a	Well	Depression	Concave	Subxeric	Medium

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Cladina mitis	11.7	6.0	2	16.5
Juniperus horizontalis	11.0	4.9	3	12.7
Juncus balticus	3.3	3.3	1	6.7
Poa pratensis	3.3	3.3	1	6.7
Populus tremuloides	3.7	2.0	2	5.2
Oryzopsis asperifolia	2.3	2.3	1	4.7
Poa palustris	2.3	2.3	1	4.7
Calamovilfa longifolia	3.0	2.1	2	4.2
Festuca saximontana	2.0	2.0	1	4.0
Schizachne purpurescens	1.7	1.7	1	3.3
Carex pensylvanica ssp heliophila	2.3	1.5	2	3.3
Juniperus communis	2.3	1.5	2	3.3
Spirea alba	2.8	1.6	3	3.3

Species	Mean % Cover	Standard Error	Presence	Prominence
Salix bebbiana	2.0	1.5	2	2.8
Solidago spathulata	1.3	0.7	2	1.9
Heterotheca villosa	1.0	0.6	2	1.4
Carex spp	0.7	0.7	1	1.3
Epilobium angustifolium	0.7	0.7	1	1.3
Koeleria macrantha	0.7	0.7	1	1.3
Artemisia campestris	0.7	0.3	2	0.9
Cladonia uncialis	0.3	0.3	1	0.7
Fragaria virginiana	0.3	0.3	1	0.7
Ribes oxyacanthoides	0.3	0.3	1	0.7
Rosa acicularis	0.3	0.3	1	0.7
Solidago candensis	0.3	0.3	1	0.7
Lathyrus ochroleucus	0.3	0.2	2	0.5
Chenopodium leptophyllum	0.2	0.2	1	0.3
Equisetum hymenale	0.2	0.2	1	0.3
Erysimum asperum	0.2	0.2	1	0.3
Viola adunca	0.2	0.2	1	0.3

This community was limited in aerial extent, primarily found in the east-central portions of the Ecological Reserve. It was typically found in low-lying, depressional sites between large, widely distributed sand dunes. Soils were sandy, with approximately 50 % low shrub and herbaceous vegetative cover. A summary of site data is provided in Table 8.

Table 8. Summary of site data for the *Betula occidentalis / Arctostaphylos uva-ursi – Juniperus horizontalis* community type (n = 3).

Plot	Elevation	Slope	Aspect	Drainage	Site Position	Surface Shape	Moisture Regime	Nutrient Regime
27	682	0	n/a	Imperfectly	Depression	Concave	Mesic	Rich
34	683	0	n/a	Well	Depression	Concave	Subxeric	Medium
35	688	0	n/a	Well	Depression	Concave	Subxeric	Medium

3.3.1 Comparison of *Betula occidentalis / Arctostaphylos uva-ursi – Juniperus horizontalis* Community to Literature

In Alberta, two *Betula occidentalis* community types have been identified and are listed in Table 9. A *Betula occidentalis* community has been reported from the Foothills Parkland and Grassland Natural regions, with some scattered occurrences in the Lower Foothills. This community was typically found on alluvial terraces, streambanks as well as on abandoned terraces along rivers and streams (Thompson and Hansen 2002). The authors noted that the water table was at the soil surface throughout the growing season. *Betula occidentalis* was dominant in the tall shrub layer, with *Salix lutea*, *Cornus stolonifera*, *Prunus virginiana* and *Rosa* spp. present in the lower shrub layers. Similarly, a *Betula occidentalis – Amelanchier alnifolia / Artemisia campestris – Elymus lanceolatus (Agropyron dasystachyum)* was found on sand dunes and swales in the Montane Natural Subregion (Allen 2003). In this community, *Betula occidentalis* and *Amelanchier alnifolia* form dense, tall patches with scattered associated species. The amount of bare sand may be as high as 90%. This community, while sharing some similar site characteristics is quite different, floristically, than the community found at Wainwright. A similar *Betula occidentalis*-dominated community has also been found on alluvial fans, in the Lower and Upper Foothills Natural Subregions, specifically west of Hinton (Keith Ainsley, pers. comm.). This community was found on coarse-textured fluvial materials, with *Juniperus horizontalis* and *Arctostaphylos uva-ursi* being common species. While these occurrences of a related community have not been documented formally, it suggests that the distribution of this community is more widely spread, than is currently reported.

Table 9. Similarity ratings for *Betula occidentalis / Arctostaphylos uva-ursi – Juniperus horizontalis* community types described from within Alberta.

Similar Communities and Citations	Similarity Rating	Comments
Betula occidentalis (Thompson and Hansen 2002)	3	This community is different floristically and has different site characteristics than that found in Wainwright.
Betula occidentalis – Amelanchier alnifolia / Artemisia campestris – Elymus lanceolatus (Agropyron dasystachyum) (Allen 2003)	3	This community, while sharing some similar site characteristics is quite different floristically than that found at Wainwright.
Betula occidentalis alluvial fan community (Ainsley, pers. comm.)	1	This community shares several similar floristic and a site characteristics to the community found in Wainwright

Numerous *Betula occidentalis* community types have been recorded outside of Alberta and are listed in Table 10. However, most of the communities differ floristically from that found within the Wainwright Dunes Ecological Reserve. Some have been identified but with too few details available to allow for proper comparison. Epp and Townley-Smith (1980) report *Betula occidentalis* communities from the Great Sandhills of Saskatchewan where it occurs in lower areas in the sand flats. Unfortunately the authors provide no further information. Montana lists three different *Betula occidentalis* natural communities for the state, (1) *Betula occidentalis – Pentaphylloides floribunda*, (2) *Betula occidentalis / Cornus sericea*, and (3) *Betula occidentalis* shrublands (MNHP 2002). Unfortunately, there are no associated descriptions available for these communities. Both Colorado (2001) and NatureServe (2003) also list a *Betula occidentalis* shrubland but unfortunately there are no additional details provided.

Several authors document a *Betula occidentalis / Cornus sericea* community from the U.S. midwest, where it occurs on floodplains in Wyoming and South Dakota, west to Washington, south to California and east to Utah (Faber-Langendoen *et al.* 2001;

Marriott and Faber-Langendoen 2000). In this community the tall-shrub layer is dominated by *Betula occidentalis* with *Cornus sericea* often co-dominating the tall-shrub layer although it may be shorter and generally contribute less cover. Scattered *Populus angustifolia* may be present, although trees usually contribute less than 10% cover. Furthermore, Hansen *et al.* (1995) document a *Betula occidentalis* riparian community from Montana, where it is found along alluvial terraces, floodplains and streambanks as well as adjacent to seeps and springs. It was typically found at low to mid elevations along high gradient streams in the eastern front, as well as in southwestern Montana. Other common species included *Cornus stolonifera, Rosa woodsii, Agrostis stolonifera* and *Poa pratensis*. Soil textures were fairly variable, ranging from loam to sandy loam.

Table 10. Similarity ratings for *Betula occidentalis / Arctostaphylos uva-ursi – Juniperus horizontalis* community types described from outside Alberta.

Similar Communities and Citations	Similarity Rating	Comments
Betula occidentalis (Epp and Townley-Smith 1980)	? (2)	This community is noted in the Great Sandhills of Saskatchewan where it occurs in lower areas in the sand flats. Unfortunately no further information is provided. As such it is difficult to assess the similarity.
Betula occidentalis – Pentaphylloides floribunda Shrubland (MNHP 2002)	? (3)	This type is listed as a natural plant community for Montana, but no description given thus no assessment of similarity could be done. Ranked G2Q / S?
Betula occidentalis / Cornus sericea Shrubland (MNHP 2002)	? (3)	This type is listed as a natural plant community for Montana, but no description given thus no assessment of similarity could be done. Ranked G3? / S?
Betula occidentalis Shrubland (MNHP 2002)	? (3)	This type is listed as a natural plant community for Montana, but no description given thus no assessment of similarity could be done. Ranked G3Q / S3
Betula occidentalis Shrubland (CNHP 2001)	? (3)	This type is listed as a natural wetland plant community for Colorado, but no description given thus no assessment of similarity could be done. Ranked G3 / S2
Betula occidentalis Shrubland (NatureServe 2003)	?(3)	This community is described as a seasonally flooded deciduous shrubland and has been recorded from Colorado, Idaho, Montana, Nevada, Washington and Wyoming. Unfortunately no further description is provided and an assessment of similarity is difficult to make.
Betula occidentalis / Cornus sericea (Faber-Langendoen *et al.* 2001; Marriott and Faber-Langendoen 2000)	3	This community is quite different in terms of site characteristics and floristic composition than that found in Wainwright.
Betula occidentalis (Hansen *et al.* 1995)	3	This community is quite different in terms of site characteristics and floristic composition than that found in Wainwright.
Betula occidentalis – Juniperus horizontalis / Calamovilfa longifolia Shrubland (Faber-Langendoen *et al.* 2001; Schneider *et al.* 1997)	?(1)	This community type is described from the northern Great Plains of the United States and Canada specifically from Manitoba and North Dakota. Unfortunately there is little information available regarding this type. This community appears to be virtually identical in species composition to that found in Wainwright.
Betula occidentalis - Juniperus horizontalis / Calamovilfa longifolia Shrubland (NatureServe 2003)	?(1)	This type is found in the northern Great Plains of the United States and Canada. Type has been described from Manitoba and North Dakota. More information is needed to clarify the concept of this type.

High water tables are a common characteristic. However, both of these communities have dramatically different site conditions that what was observed at the Wainwright Dunes ecological reserve.

NatureServe (2003) and several authors (Faber-Langendoen *et al.* 2001; Schneider *et al.* 1997) report a *Betula occidentalis – Juniperus horizontalis / Calamovilfa longifolia* Shrubland which appears to be more closely related to the community observed in Wainwright. The authors document this community type from the northern Great Plains of the United States and Canada specifically from Manitoba and North Dakota. Unfortunately there is little additional information available regarding this type.

3.3.2 Preliminary Conservation Ranking of *Betula occidentalis / Arctostaphylos uva-ursi – Juniperus horizontalis* Community

Preliminary Rank: ***S2S3***

A review of floristically related plant communities throughout the Aspen Parkland and Great Plains regions revealed that *Betula occidentalis* dominated community types have generally been documented only in riparian zones. Furthermore, the riparian communities also typically have a *Cornus stolonifera* component. There is a mention of a *Betula occidentalis* dominated community from the Great Sand Hills in Saskatchewan, but no further details are provided. Several authors document a *Betula occidentalis – Juniperus horizontalis / Calamovilfa longifolia* community from Manitoba south through North Dakota (NatureServe 2003; Faber-Langendoen *et al.* 2001; Schneider *et al.* 1997). This community is not seasonally or periodically flooded, however more information is required to clarify the concept of this type (NatureServe 2003). Superficially, this community sounds quite similar to the community found in Wainwright. A similar *Betula occidentalis*-dominated community has also been found on alluvial fans, in the Lower and Upper Foothills Natural Subregions (Keith Ainsley, pers. comm.). The Foothills community was found on coarse-textured fluvial materials, with *Juniperus horizontalis* and *Arctostaphylos uva-ursi* being common species. While these occurrences of a related community have not been documented formally, it suggests that the distribution of this community is more widely spread, than is currently reported.

As such, a preliminary rank of **S2S3** is suggested for this community type until further information becomes available. Additional plots from eolian landscapes within Alberta would help to clarify the distribution of this community type.

3.4 Calamovilfa longifolia - Sporobolus cryptandrus - Carex siccata Association

Sand grass – sand dropseed – hay sedge

Plate 2. *Calamovilfa longifolia - Sporobolus cryptandrus - Carex siccata* (Sand grass – sand dropseed – hay sedge) Plot 19.

This community type was co-dominated by *Calamovilfa longifolia, Sporobolus cryptandrus* and *Carex siccata* in the graminoid stratum with each species typically having a cover of greater than 15 %. This community was found on dune slopes where sand movement was somewhat active. Few shrub or forb species were present, although *Chenopodium leptophyllum* (status unknown [SU] ANHIC 2002), *Heterotheca villosa*, and *Chenopodium pratericola* were found in two of the three sites sampled. Only one shrub species, *Juniperus horizontalis*, was encountered at one of the survey sites, however it occurred with less than 1 % cover. Other forb and graminoid species were found at different survey sites, but few were common to all or most plots. Table 11 summarizes the species composition, mean percent cover, standard error and species prominence for this community type.

Table 11. Summary statistics for the *Calamovilfa longifolia - Sporobolus cryptandrus - Carex siccata* community type (n = 3).

Species	Mean % Cover	Standard Error	Presence	Prominence
Calamovilfa longifolia	20.0	5.0	3	20.0
Sporobolus cryptandrus	18.3	6.0	3	18.3
Carex siccata	16.7	6.7	3	16.7
Stipa comata	2.3	1.5	2	2.9
Helianthus annuus	2.0	1.5	2	2.4
Cladina mitis	0.7	0.7	1	1.2
Elymus candensis	0.7	0.7	1	1.2
Festuca saximontana	0.7	0.7	1	1.2
Juniperus horizontalis	0.7	0.7	1	1.2
Koeleria macrantha	0.7	0.7	1	1.2
Chenopodium pratericola	0.5	0.3	2	0.6
Heterotheca villosa	0.5	0.3	2	0.6
Equisetum hymenale	0.3	0.3	1	0.6
Chenopodium leptophyllum	0.3	0.2	2	0.4
Artemisia campestris	0.2	0.2	1	0.3
Chamaerhodos erecta	0.2	0.2	1	0.3
Erysimum asperum	0.2	0.2	1	0.3
Gaura coccinea	0.2	0.2	1	0.3

The *Calamovilfa longifolia - Sporobolus cryptandrus - Carex siccata* community was found on south to southwest facing slopes of relatively active dunes. Some sand movement was evident and all sites the percentage of exposed sand exceeded 60 %. There was little organic matter accumulation at the soil surface. A summary of site data is provided in Table 12.

Table 12. Summary of site data for the *Calamovilfa longifolia - Sporobolus cryptandrus - Carex siccata* community type (n = 3).

Plot	Elevation	Slope	Aspect	Drainage	Site Position	Surface Shape	Moisture Regime	Nutrient Regime
19	670	26	238	Rapidly	Middle Slope	Straight	Xeric	Poor
21	670	23	216	Rapidly	Middle Slope	Concave	Xeric	Poor
28	692	43	236	Rapidly	Middle Slope	Straight	Subxeric	Poor

3.4.1 Comparison of *Calamovilfa longifolia - Sporobolus cryptandrus - Carex siccata* Community to Literature

A number of similar communities to the *Calamovilfa longifolia – Sporobolus cryptandrus – Carex siccata* community have been identified in Alberta and are listed in Table 13. In a 1984 biophysical inventory of the Wainwright Dunes Ecological Reserve, Fehr noted an "active blowout" community type. Fehr described this community as having a canopy cover of herb-dwarf shrubs that averaged approximately 23%. He noted that the organic matter on the soil surfaces averaged 4% while the exposed mineral at the soil surfaces averaged almost 90%. Most of the plant species found in the active blowout were important colonizers of bare sand, including *Carex foenea, Calamovilfa longifolia, Elymus canadensis, Oryzopsis hymenoides, Festuca saximontana*, and *Chrysopsis villosa*. A *Calamovilfa longifolia – Sporobolus cryptandrus – Koeleria macrantha – Carex obtusata* community was found on sand dunes and active blowouts at Dillberry Lake Provincial Park (Meijer and Karpuk 1999). This community was noted to typically have a south to southwest facing aspect, a xeric moisture regime and *Juniperus horizontalis* and *Heterotheca villosa* as associated species. This community appears to be quite similar to that found in Wainwright, although several species are different.

In the Pakowki Sandhills in southern Alberta, two community types were identified that were similar to the *Calamovilfa longifolia – Sporobolus cryptandrus – Carex siccata* community found in the Wainwright Dunes Ecological Reserve:

1. *Calamovilfa longifolia – Sporobolus cryptandrus* community type (Komex 1993)
2. *Sporobolus cryptandrus – Calamovilfa longifolia - Oryzopsis hymenoides* community type (Coenen and Bentz 2003)

Coenen and Bentz (2003) reported that the *Sporobolus cryptandrus – Calamovilfa longifolia - Oryzopsis hymenoides* community was co-dominated by *Sporobolus cryptandrus* and *Calamovilfa longifolia*, with lesser amounts of *Oryzopsis hymenoides*. Low shrubs were present at some survey sites, however, the percent cover was quite low. A forb layer was typically present and included species such as *Helianthus annuus, Lygodesmia rostrata* and *Heterotheca villosa*. The community was typically found on gentle to moderate southeast to southwest facing dune slopes. The dunes were partially active, however vegetation growth was beginning to stabilize the dune. Typically, there was greater than 50 % exposed sand at the soil surface, with very little organic matter accumulation. Additionally, a *Sporobolus cryptandrus* semi-active dune community type is tracked by ANHIC (Allen 2003; Thorpe and Godwin 1993) where it is known from the Dry Mixedgrass and Central Parkland subregions, occurring on partially stabilized dunes. The soils were noted to be coarse textured and rapidly drained.

Table 13. Similarity ratings for *Calamovilfa longifolia - Sporobolus cryptandrus - Carex siccata* community types described from within Alberta.

Similar Communities and Citations	Similarity Rating	Comments
Active blowout (Fehr 1984)	1	This community description fits with the observed site characteristics with few differences in species composition.
Calamovilfa longifolia – Sporobolus cryptandrus – Koeleria macrantha – Carex obtusata (Meijer and Karpuk 1999)	1	This community appears to be quite similar to that found in Wainwright, although several species are different.
Sporobolus cryptandrus – Calamovilfa longifolia - Oryzopsis hymenoides community type (Coenen and Bentz 2003)	2	While the site characteristics of this community is quite similar to that observed at Wainwright, the species composition is somewhat different.
Calamovilfa longifolia – Sporobolus cryptandrus community type (Komex 1993)	2	While the site characteristics of this community is quite similar to that observed at Wainwright, the species composition is somewhat different.
Sporobolus cryptandrus semi-active dune (Allen 2003; Thorpe and Godwin 1993)	2	While the site characteristics of this community is quite similar to that observed at Wainwright, the species composition is somewhat different.

Numerous related community types have been recorded outside of Alberta and they are listed in Table 14. However, most of the communities differ floristically from that found within the Wainwright Dunes Ecological Reserve. Some have been identified but with too few details available to allow for proper comparison. Thorpe and Godwin (1993) describe a *Carex pennsylvanica – Sporobolus cryptandrus – Cyperus schwentzeii – Calamovilfa longifolia* community that occurs on sparsely vegetated, active east/west oriented sand dunes in the Manito Sandhills of Saskatchewan. The soils were noted to be coarse-textured and had little to no organic matter to retain moisture. The site conditions described here were very similar to that observed in the Wainwright area. Faber-Langendoen (2001; NatureServe 2003) described a *Calamovilfa longifolia - Hesperostipa comata* community found in the central and northern Great Plains region, ranging from Colorado and Nebraska, north to Wyoming and South Dakota. The vegetation has an open canopy and is dominated by mid to tall grasses. *Calamovilfa longifolia* was the most prominent grass although *Bouteloua gracilis, Bouteloua gracilis, Koeleria macrantha, Achnatherum hymenoides, Sporobolus cryptandrus* and *Hesperostipa comata* are quite common. Sedges are reported to be uncommon but may include *Carex inops ssp. heliophila*. This community was frequently found on stabilized sand dunes, as well as in interdunal valleys or draws.

Several authors have described a *Calamovilfa longifolia - Carex inops ssp. heliophila* community type from the northwestern Great Plains, ranging from the western Dakotas to Montana and Saskatchewan (NatureServe 2003; Faber-Langendoen 2001; Schneider *et al.* 1997). The vegetation structure is somewhat open, with total cover averaging 65%. Graminoids were dominant, with *Calamovilfa longifolia* as the dominant tall grass although *Koeleria macrantha, Schizachyrium scoparium* and *Hesperostipa comata* could also be present. The short-grass layer was composed primarily of *Carex filifolia and Carex inops ssp. heliophila*. Forb species diversity was noted to be moderate, and often included *Artemisia dracunculus, Artemisia frigida, Artemisia ludoviciana, Chenopodium album, Chenopodium leptophyllum, Lathyrus spp., Liatris punctata, Lygodesmia juncea, Phlox hoodii* and *Psoralidium lanceolatum* although they do not contribute much cover. This community was typically found on gently rolling uplands with gentle to moderate slopes (0 – 20%, up 39%) with sandy, sandy loam, or loamy sand soils.

Table 14. Similarity ratings for *Calamovilfa longifolia - Sporobolus cryptandrus - Carex siccata* community types described from outside Alberta.

Similar Communities and Citations	Similarity Rating	Comments
Carex pennsylvanica – Sporobolus cryptandrus – Cyperus schwentzeii – Calamovilfa longifolia on active sand (Thorpe and Godwin 1993)	1	Site conditions very similar, almost identical. However the floristic composition was slightly different (more variable grass species).
Calamovilfa longifolia - Hesperostipa comata Herbaceous Vegetation (NatureServe 2003; Faber-Langendoen 2001)	2	This community shares some floristic similarities and general site characteristics observed in Wainwright.
Calamovilfa longifolia - Carex inops ssp. heliophila Herbaceous Vegetation (NatureServe 2003; Faber-Langendoen 2001; Schneider *et al.* 1997)	2	This community shares many floristic similarities and matches the site characteristics observed in Wainwright.
Calamovilfa longifolia / Carex heliophila (Hansen and Hoffman 1988)	2	This community shares many floristic similarities and matches the site characteristics observed in Wainwright.
Calamovilfa longifolia – Andropogon hallii (Schneider *et al.* 1997)	?(3)	No description of community type is given, thus cannot assess similarity. However, superficially it appears to be floristically quite different.
Calamovilfa longifolia – Carex filifolia (Schneider *et al.* 1997)	?(3)	No description of community type is given, thus cannot assess similarity. However, superficially it appears to be floristically quite different.
Calamovilfa longifolia – Oryzopsis hymenoides (Schneider *et al.* 1997)	?(3)	No description of community type is given, thus cannot assess similarity. However, superficially it appears to be floristically quite different.
Sandgrass Type (Hanson and Whitman 1938)	2	There are a number of floristic similarities although the site conditions are somewhat different although on a sandy substrate.
Calamovilfa longifolia – Carex inops ssp. heliophila (MNHP 2002)	? (2)	This type is listed as a natural plant community for Montana, but no description given thus no assessment of similarity could be done. Ranked G3 / S3?
Calamovilfa longifolia – Stipa comata (MNHP 2002)	? (3)	This type is listed as a natural plant community for Montana, but no description given thus no assessment of similarity could be done. Ranked G3 / S3

Hansen and Hoffman (1988) documented a *Calamovilfa longifolia / Carex heliophila* community from the Custer National Forest in Montana and South Dakota, where it occurs on rolling landscapes. Where this community was found in an undisturbed state, little other than the two dominant species occur although occasional plants of *Bouteloua gracilis, Koeleria macrantha* and *Artemisia ludoviciana* did occur generally with low covers. The soil textures in this community ranged from sandy loams to sands. Schneider *et al.* (1997; NatureServe 2003) documented three different community types, all dominated by *Calamovilfa longifolia.* A *Calamovilfa longifolia – Andropogon hallii* community is recorded from Manitoba, Montana, North and South Dakota and Saskatchewan, a *Calamovilfa longifolia – Carex filifolia* community is noted from Montana, North and South Dakota and Wyoming, and a *Calamovilfa longifolia – Oryzopsis hymenoides* community from Saskatchewan is also documented. Unfortunately no further details are provided, detailing their composition or site conditions.

Hanson and Whitman (1938) described a Sandgrass Type from North Dakota where it is found on residual, sandy hills and ridges. Common species included *Calamovilfa longifolia Carex filifolia, C. stenophylla, C. pensylvanica, Bouteloua gracilis, Stipa comata,* and *Koeleria cristata.* The Montana Natural Heritage Program (2002) lists two sand grass communities from Montana; (1) *Calamovilfa longifolia – Carex inops ssp. heliophila* and (2) *Calamovilfa longifolia – Stipa comata.* Unfortunately, no further details were provided.

3.4.2 Preliminary Conservation Ranking of *Calamovilfa longifolia - Sporobolus cryptandrus - Carex siccata* Community

Preliminary Rank: ***S2S3***

This community appears to be documented in several sources, through Alberta, Saskatchewan and the Great Plains states. The main limitation to the occurrence of this community is the availability and size of appropriate habitat, namely active sand dunes and blowouts. As such, there is a significant limitation to the expected distribution of this community type. A preliminary rank of **S2S3** is suggested for this community type.

3.5 *Elaeagnus commutata - Prunus virginiana / Carex siccata - Koeleria macrantha* Association

Silverberry – chokecherry / hay sedge – june grass

Plate 3. *Elaeagnus commutata - Prunus virginiana / Carex siccata - Koeleria macrantha* (Silverberry – chokecherry / hay sedge – june grass) Plot 31.

The *Elaeagnus commutata - Prunus virginiana / Carex siccata - Koeleria macrantha* community was very limited in aerial extent within the Wainwright Dunes Ecological Reserve. *Elaeagnus commutata* and *Prunus virginiana* are co-dominant mid-shrub species that characterize this community. *Carex siccata* was the dominant graminoid species, typically with greater than 15 % cover, although *Koeleria macrantha* was present at each site sampled with a cover greater than 5 %. Other graminoid species included *Calamovilfa longifolia, Stipa spartea,* and *Agrostis scabra,* although typically with a mean percent cover of less than 5 %. *Selaginella densa, Artemisia campestris, Solidago missouriensis, Lepidium densiflorum* and *Equisetum hymenale* were also recurring species with less than 5 % cover. Table 15 summarizes the species composition, mean percent cover, standard error and species prominence for this community type.

Table 15. Summary statistics for the *Elaeagnus commutata - Prunus virginiana / Carex siccata - Koeleria macrantha* community type (n = 3).

Species	Mean % Cover	Standard Deviation	Standard Error	Presence	Prominence
Elaeagnus commutata	21.7	11.5	6.7	3	21.7
Carex siccata	18.3	2.9	1.7	3	18.3
Prunus virginiana	15.2	12.9	7.5	3	15.2
Koeleria macrantha	8.3	2.9	1.7	3	8.3
Stipa comata	5.7	8.1	4.7	2	6.9
Populus tremuloides	4.3	5.1	3.0	2	5.3
Calamovilfa longifolia	4.7	2.5	1.5	3	4.7
Selaginella densa	4.3	1.2	0.7	3	4.3
Stipa spartea	4.0	2.6	1.5	3	4.0
Symphoricarpos occidentalis	1.7	2.9	1.7	1	2.9
Bouteloua gracilis	2.3	2.5	1.5	2	2.9
Poa pratensis	2.3	2.5	1.5	2	2.9
Cladina mitis	2.3	0.6	0.3	3	2.3
Amelanchier alnifolia	1.3	2.3	1.3	1	2.3
Artemisia campestris	2.0	2.6	1.5	3	2.0
Solidago missouriensis	2.0	1.0	0.6	3	2.0
Agrostis scabra	1.7	1.2	0.7	3	1.7
Rosa arkansana	1.7	0.6	0.3	3	1.7
Heterotheca villosa	1.3	1.2	0.7	2	1.6
Artemisia frigida	1.0	1.0	0.6	2	1.2
Solidago spathulata	0.7	1.2	0.7	1	1.2
Lepidium densiflorum	1.0	0.9	0.5	3	1.0
Equisetum hymenale	0.8	0.3	0.2	3	0.8
Artemisia ludoviciana	0.7	0.6	0.3	2	0.8
Anemone multifida	0.3	0.6	0.3	1	0.6
Arabis holboellii	0.3	0.6	0.3	1	0.6
Carex filifolia	0.3	0.6	0.3	1	0.6
Chenopodium pratericola	0.3	0.6	0.3	1	0.6
Festuca saximontana	0.3	0.6	0.3	1	0.6
Hackelia americana	0.3	0.6	0.3	1	0.6
Helianthus annuus	0.3	0.6	0.3	1	0.6
Erysimum asperum	0.3	0.3	0.2	2	0.4
Descurainia sophia	0.2	0.3	0.2	1	0.3
Gaura coccinea	0.2	0.3	0.2	1	0.3
Silene drummondii	0.2	0.3	0.2	1	0.3

This community type was typically found on lower slope to depressional landscape positions and generally had a level to concave surface shape. Sites had some organic matter accumulation at the soil surface, but small patches of expose sand were visible in some sites. A summary of site data is provided in Table 16.

Table 16.Summary of site data for the *Elaeagnus commutata - Prunus virginiana / Carex siccata - Koeleria macrantha* community type (n = 3).

Plot	Elevation	Slope	Aspect	Drainage	Site Position	Surface Shape	Moisture Regime	Nutrient Regime
24	670	0	n/a	Moderately Well	Depression	Concave	Submesic	Medium
31	707	3	218	Well	Toe	Concave	Submesic	Medium
33	709	13	212	Well	Lower Slope	Straight	Subxeric	Poor

Table 15. Summary statistics for the *Elaeagnus commutata - Prunus virginiana / Carex siccata - Koeleria macrantha* community type (n = 3).

Species	Mean % Cover	Standard Deviation	Standard Error	Presence	Prominence
Elaeagnus commutata	21.7	11.5	6.7	3	21.7
Carex siccata	18.3	2.9	1.7	3	18.3
Prunus virginiana	15.2	12.9	7.5	3	15.2
Koeleria macrantha	8.3	2.9	1.7	3	8.3
Stipa comata	5.7	8.1	4.7	2	6.9
Populus tremuloides	4.3	5.1	3.0	2	5.3
Calamovilfa longifolia	4.7	2.5	1.5	3	4.7
Selaginella densa	4.3	1.2	0.7	3	4.3
Stipa spartea	4.0	2.6	1.5	3	4.0
Symphoricarpos occidentalis	1.7	2.9	1.7	1	2.9
Bouteloua gracilis	2.3	2.5	1.5	2	2.9
Poa pratensis	2.3	2.5	1.5	2	2.9
Cladina mitis	2.3	0.6	0.3	3	2.3
Amelanchier alnifolia	1.3	2.3	1.3	1	2.3
Artemisia campestris	2.0	2.6	1.5	3	2.0
Solidago missouriensis	2.0	1.0	0.6	3	2.0
Agrostis scabra	1.7	1.2	0.7	3	1.7
Rosa arkansana	1.7	0.6	0.3	3	1.7
Heterotheca villosa	1.3	1.2	0.7	2	1.6
Artemisia frigida	1.0	1.0	0.6	2	1.2
Solidago spathulata	0.7	1.2	0.7	1	1.2
Lepidium densiflorum	1.0	0.9	0.5	3	1.0
Equisetum hymenale	0.8	0.3	0.2	3	0.8
Artemisia ludoviciana	0.7	0.6	0.3	2	0.8
Anemone multifida	0.3	0.6	0.3	1	0.6
Arabis holboellii	0.3	0.6	0.3	1	0.6
Carex filifolia	0.3	0.6	0.3	1	0.6
Chenopodium pratericola	0.3	0.6	0.3	1	0.6
Festuca saximontana	0.3	0.5	0.3	1	0.6
Hackelia americana	0.3	0.6	0.3	1	0.6
Helianthus annuus	0.3	0.6	0.3	1	0.6
Erysimum asperum	0.3	0.3	0.2	2	0.4
Descurainia sophia	0.2	0.3	0.2	1	0.3
Gaura coccinea	0.2	0.3	0.2	1	0.3
Silene drummondii	0.2	0.3	0.2	1	0.3

This community type was typically found on lower slope to depressional landscape positions and generally had a level to concave surface shape. Sites had some organic matter accumulation at the soil surface, but small patches of expose sand were visible in some sites. A summary of site data is provided in Table 16.

Table 16.Summary of site data for the *Elaeagnus commutata - Prunus virginiana / Carex siccata - Koeleria macrantha* community type (n = 3).

Plot	Elevation	Slope	Aspect	Drainage	Site Position	Surface Shape	Moisture Regime	Nutrient Regime
24	670	0	n/a	Moderately Well	Depression	Concave	Submesic	Medium
31	707	3	218	Well	Toe	Concave	Submesic	Medium
33	709	13	212	Well	Lower Slope	Straight	Subxeric	Poor

3.5.1 Comparison of *Elaeagnus commutata - Prunus virginiana / Carex siccata - Koeleria macrantha* Community to Literature

A number of *Elaeagnus commutata* community types have been reported in Alberta and elsewhere and are listed in Table 17. However, none are considered to be the same as the one identified in the in the Wainwright Dunes Ecological Reserve. Fehr described a slightly different *Elaeagnus commutata/ Symphoricarpos occidentalis – Rosa woodsii / Poa palustris* community from a 1984 survey of the Wainwright Dunes Ecological Reserve. This community was found typically in subxeric and submesic locations where drainage was good. Low shrub cover averaged 80% and the herb-dwarf shrub cover averaged 50%. *Elaeagnus commutata* generally had 40% cover and was the only tall shrub present. The low shrub layer included buckbrush, *Rosa woodsii* and *Ribes oxyacanthoides*. Another *Elaeagnus commutata* community type has been described from three locations in the Central Parkland by several authors (Meijer and Karpuk 1999; Fehr 1982; Bradley and Bradley 1972). Typically *Elaeagnus commutata* contributed at least 50% cover, occurring as low shrublands and shrubby meadows as a fringe around saline lakes adjacent to marshes or graminoid meadows. Common associated species included *Symphoricarpos occidentalis, Rosa acicularis, Carex spp., Calamovilfa longifolia,* and *Agropyron trachycaulum.*

Adams *et al.* (1997) documented an *Elaeagnus commutata / Stipa comata* community type from the CFB Suffield National Wildlife Area, in southern Alberta. There was no information provided, as far as its floristic composition and site characteristics, as it was considered to be minor or indistinct community that would be further developed with additional field sampling. Several communities have been described from the Pakowki Sandhills area, specifically an *Elaeagnus commutata / Glycyrrhiza lepidota* and an *Elaeagnus commutata / Artemisia ludoviciana / Calamovilfa longifolia* community type (Coenen and Bentz 2003; Komex 1993). The *Elaeagnus commutata / Glycyrrhiza lepidota* community also included associated forbs such as *Artemisia ludoviciana, Thermopsis rhombifolia, Cryptantha fendleri* and *Chenopodium pratericola. Juncus balticus* was noted to be the dominant graminoid species, although other species such as *Stipa comata, Koeleria macratha* and *Agropyron dasystachyum* were also present. These community types occurred in depressional locations on the windward side of dunes, with well-drained soils. The *Elaeagnus commutata / Artemisia ludoviciana / Calamovilfa longifolia* community occurred in a small downslope-trending depression or gully on the windward side of a dune. The dune appeared to be quite stabilized with a high vegetative cover Other graminoid species included *Stipa comata, Cyperus schweinitzii, Sporobolus cryptandrus, Koeleria macrantha* and *Agropyron dasystachyum* generally with covers of less than 1%. *Artemisia ludoviciana* was the dominant forb with about 5 % cover. An *Elaeagnus commutata* community has also been reported from the Foothills and Montane subregions where it forms stringers on stream terraces. Common associated species include *Salix spp., Amelanchier alnifolia* and *Prunus virginiana* (Allen 2003).

Table 17. Similarity rating *Elaeagnus commutata - Prunus virginiana / Carex siccata - Koeleria macrantha* community types documented within Alberta.

Similar Communities and Citations	Similarity Rating	Comments
Elaeagnus commutata/ Symphoricarpos occidentalis – Rosa woodsii / Poa palustris (Wheatley and Bentz 2002; Fehr 1984)	2	While site characteristics are quite similar, the species composition and structure seems somewhat different than those found in this field survey. Fehr only sampled 1 site in the community type however.
Elaeagnus commutata (Meijer and Karpuk 1999; Fehr 1982; Bradley and Bradley 1972)	2	The species composition and site characteristics of this community are quite different than those observed in the Wainwright Dunes Ecological Reserve.
Elaeagnus commutata / Stipa comata (Adams *et al.* 1997)	?	There is no information provided regarding the floristic composition and site characteristics of this community as it is considered to be minor or indistinct community that will be further developed with additional field sampling. As such it is difficult to assess its similarity to the community found in Wainwright.
Elaeagnus commutata / Artemisia ludoviciana / Calamovilfa longifolia (Coenen and Bentz 2003; Komex 1993)	2	This community is somewhat floristically different with slightly different site characteristics than that observed at Wainwright.
Elaeagnus commutata / Glycyrrhiza lepidota (Coenen and Bentz 2003)	2	This community is somewhat floristically different with slightly different site characteristics than that observed at Wainwright.
Elaeagnus commutata (Allen 2003)	3	This community is quite different in site characteristics and species composition than that found in Wainwright.

Outside of Alberta, there are numerous reports of *Elaeagnus commutata* dominated communities and these are listed in Table 18. An *Elaeagnus commutata – Rosa woodsii – Symphoricarpos occidentalis – Prunus virginiana* community is described from the Great Sandhills in Saskatchewan where it occurs in low areas between dunes and also on stabilized slip faces, typically north-facing (Epp and Townley-Smith 1980). Shrub composition varied location to location and each shrub species may be dominant at specific sites, where at others may be co-dominant. Coupland (1950) described a *Rosa woodsii (Artemisia cana / Elaeagnus commutata*) community from the Canadian Prairie provinces. This community occurred in undulating to gently rolling areas between stabilized dunes where the water table was typically within 8 to 12 feet of the soil surface. Looman (1983) also described an Alliance Elaeagnion commtatae that community was described from the Canadian Prairie Provinces, where it was found on sandy or stony soils. Associated species included *Rosa acicularis, Prunus virginiana,* and *Ribes oxyacanthoides*.

An *Elaeagnus commutata / Pascopyrum smithii* community is described in Manitoba, Montana, North Dakota and Saskatchewan (NatureServe 2003; MNHP 2002; Schneider *et al.* 1997). This community occurred on a variety of glacial landforms including kames, eskers and areas of till and outwash. It was commonly found on north-facing slopes and sites where moisture was more abundant, including along river valley slopes. The vegetation formed open thickets within the mixed-grass prairie landscape. *Elaeagnus commutata* was generally a short to medium height shrub. *Pascopyrum smithii* was not a dominant species at Wainwright, so it floristically different. An *Elaeagnus commutata* community is documented from northern Montana, east of Continental divide (MNHP 2002; Heidel *et al.* 2000). This community was classified as temporarily flooded, hence it is not thought to be similar to the community found in the Wainwright Dunes Ecological Reserve. In the Medicine Lake sandhills in Montana, sites had shrub cover of 10% and grass cover of 70%. NatureServe (2003) also reported an *Elaeagnus commutata* community from the northern Great Plains in a mixedgrass prairie matrix. It was dominated by mid to tall shrubs, especially *Elaeagnus commutata*. *Pascopyrum smithii* was dominant in the herbaceous layer, typically accompanied by *Koeleria macrantha*, *Schizachyrium scoparium* and *Hesperostipa comata*. *Elaeagnus commutata* was noted to be most abundant on flat sandy sites in southern Saskatchewan.

Table 18. Similarity rating for *Elaeagnus commutata - Prunus virginiana / Carex siccata - Koeleria macrantha* community types documented outside Alberta.

Similar Communities and Citations	Similarity Rating	Comments
Elaeagnus commutata – Rosa woodsii – Symphoricarpos occidentalis – Prunus virginiana (Epp and Townley-Smith 1980)	2	The floristic composition and site conditions are quite different than that observed at Wainwright..
Rosa woodsii (Artemisia cana / Elaeagnus commutata) (Coupland 1950)	2	Species composition different, though quite general, than that found at Wainwright dunes region, but site conditions quite similar.
Alliance Elaeagnion commutatae (Looman 1983)	2	Species composition different, though quite general, than that found at Wainwright dunes region, but site conditions quite similar.
Elaeagnus commutata / Pascopyrum smithii (Schneider *et al.* 1997)	?(3)	No description provided, although it's noted to occur in Manitoba, Montana, North Dakota and Saskatchewan. The authors suggest a conservation rating of G2. No description of community type is given, thus cannot assess similarity.
Elaeagnus commutata / Pascopyrum smithii Shrubland (NatureServe 2003; MNHP 2002)	3	*Pascopyrum smithii* not a dominant species at Wainwright. Although substrates described in this report are coarse, they are different than eolian landforms.
Elaeagnus commutata Shrubland Alliance (NatureServe 2003; MNHP 2002; Heidel *et al.* 2000)	2	Site conditions, being somewhat more level with a sandy substrate, are similar. However the community is described here as temporarily flooded, whereas Wainwright not likely experiencing flooding.

3.5.2 Preliminary Conservation Ranking of *Elaeagnus commutata - Prunus virginiana / Carex siccata - Koeleria macrantha* Community

Preliminary Rank: ***S2?***

A survey of Dillberry Lake Provincial Park reported a related, though not entirely similar *Elaeagnus commutata* dominated community type (Meijer and Karpuk 1999), which has been assigned a preliminary conservation ranking of S2 (Wheatley and Bentz 2002). While the community found in the Wainwright Ecological Reserve does differ somewhat in the floristic composition and the site conditions, it is still not a common, widespread community type. This community occurs as small patches, typically scattered at wide-ranging intervals across the landscape. As such, a preliminary rank of **S2?** is suggested for this community type and additional sampling both within the Wainwright Dunes Ecological Reserve and other sand dune and sand plain habitats could help to careful the status of this community type.

3.6 *Juniperus horizontalis / Stipa comata - Carex siccata* Association

Creeping juniper / needle-and-thread – hay sedge

Plate 4. *Juniperus horizontalis / Stipa comata - Carex siccata* community type (Creeping juniper / needle-and-thread – hay sedge) Plot 38.

This community is widespread and extensive, and is dominated by *Juniperus horizontalis* in the low-shrub stratum, with *Stipa comata* and *Carex siccata* co-dominating the graminoid stratum. Combined, *S. comata* and *C. siccata* typically provide greater than 30 % cover. *Calamovilfa longifolia*, *Koeleria macrantha*, and *Festuca saximontana* were also present at the majority of sites sampled, but with lesser prominence. Other common species, with lower coverages include *Prunus virginiana*, *Selaginella densa*, *Cladina mitis*, *Artemisia frigida*, *Solidago missouriensis* and *Chenopodium pratericola*. Table 19 summarizes the species composition, mean percent cover, standard error and species prominence for this community type.

Table 19. Summary statistics for the *Juniperus horizontalis / Stipa comata - Carex siccata* community type (n = 6).

Species	Mean % Cover	Standard Error	Presence	Prominence
Juniperus horizontalis	17.0	3.0	6	15.5
Stipa comata	16.8	3.7	6	15.3
Carex siccata	15.0	1.7	6	13.7
Arctostaphylos uva-ursi	7.0	4.9	2	11.1
Calamovilfa longifolia	9.4	1.0	6	8.6
Koeleria macrantha	8.8	1.6	6	8.0
Cladina mitis	8.0	1.7	6	7.3
Selaginella densa	7.0	1.6	5	7.0
Artemisia frigida	5.6	1.6	5	5.6
Prunus virginiana	4.0	1.4	5	4.0
Stipa spartea	2.5	1.3	3	3.2
Festuca saximontana	2.5	0.7	5	2.5
Solidago missouriensis	2.0	0.8	4	2.2
Spirea alba	1.0	0.8	1	2.2
Bouteloua gracilis	1.4	0.8	2	2.2
Helictotrichon hookeri	1.4	0.8	2	2.2
Solidago spathulata	1.2	0.8	2	1.9
Thermopsis rhombifolia	1.4	0.7	3	1.8
Heterotheca villosa	1.6	0.4	4	1.8
Artemisia ludoviciana	1.2	0.5	3	1.5
Chenopodium pratericola	1.4	0.5	5	1.4
Rosa arkansana	0.9	0.3	4	1.0
Carex filifolia	0.6	0.3	2	0.9

Species	Mean % Cover	Standard Error	Presence	Prominence
Cladonia uncialis	0.5	0.3	2	0.8
Equisetum hymenale	0.4	0.2	3	0.5
Gaillardia aristata	0.4	0.2	3	0.5
Populus tremuloides	0.4	0.2	3	0.5
Erysimum asperum	0.5	0.1	5	0.5
Festuca hallii	0.3	0.2	2	0.5
Agropyron dasystachyum	0.2	0.2	1	0.4
Juncus balticus	0.2	0.2	1	0.4
Opuntia fragilis	0.2	0.2	1	0.4
Anemone patens	0.2	0.1	2	0.3
Artemisia campestris	0.2	0.1	2	0.3
Chenopodium leptophyllum	0.2	0.1	2	0.3
Agoseris glauca	0.1	0.1	1	0.2
Arabis holboellii	0.1	0.1	1	0.2
Chenopodium album	0.1	0.1	1	0.2
Gallium boreale	0.1	0.1	1	0.2
Gaura coccinea	0.1	0.1	1	0.2
Helianthus annuus	0.1	0.1	1	0.2
Kochia scoparia	0.1	0.1	1	0.2
Lepidium densiflorum	0.1	0.1	1	0.2
Poa interior	0.1	0.1	1	0.2
Potentilla hippiana	0.1	0.1	1	0.2
Silene drummondii	0.1	0.1	1	0.2
Viola adunca	0.1	0.1	1	0.2

The *Juniperus horizontalis / Stipa comata - Carex siccata* community was typically found on level to gentle slopes that were at least well drained and subxeric. The soil surface typically had a shallow organic matter accumulation, although small patches of exposed soils were occasionally present. A summary of site data is provided in Table 20.

Table 20. Summary of site data for the *Juniperus horizontalis / Stipa comata - Carex siccata* community type (n = 6).

Plot	Elevation	Slope	Aspect	Drainage	Site Position	Surface Shape	Moisture Regime	Nutrient Regime
7	688	0	n/a	Rapidly	Upper Slope	Convex	Subxeric	Poor
15	695	5	125	Well	Middle Slope	Straight	Subxeric	Medium
22	670	3	348	Well	Middle Slope	Straight	Subxeric	Poor
26	683	0	n/a	Well	Crest	Convex	Subxeric	Medium
32	700	13	230	Well	Lower Slope	Straight	Subxeric	Medium
38	668	16	291	Well	Middle Slope	Concave	Subxeric	Poor

Table 19. Summary statistics for the *Juniperus horizontalis / Stipa comata - Carex siccata* community type (n = 6).

Species	Mean % Cover	Standard Error	Presence	Prominence
Juniperus horizontalis	17.0	3.0	6	15.5
Stipa comata	16.8	3.7	6	15.3
Carex siccata	15.0	1.7	6	13.7
Arctostaphylos uva-ursi	7.0	4.9	2	11.1
Calamovilfa longifolia	9.4	2.0	6	8.6
Koeleria macrantha	8.8	1.6	6	8.0
Cladina mitis	8.0	1.7	6	7.3
Selaginella densa	7.0	1.8	5	7.0
Artemisia frigida	5.6	1.6	5	5.6
Prunus virginiana	4.0	1.4	5	4.0
Stipa spartea	2.5	1.3	3	3.2
Festuca saximontana	2.5	0.7	5	2.5
Solidago missouriensis	2.0	0.8	4	2.2
Spiraea alba	1.0	0.8	1	2.2
Bouteloua gracilis	1.4	0.8	2	2.2
Helictotrichon hookeri	1.4	0.8	2	2.2
Solidago spathulata	1.2	0.8	2	1.9
Thermopsis rhombifolia	1.4	0.7	3	1.8
Heterotheca villosa	1.6	0.4	4	1.8
Artemisia ludoviciana	1.2	0.5	3	1.5
Chenopodium pratericola	1.4	0.5	5	1.4
Rosa arkansana	0.9	0.3	4	1.0
Carex filifolia	0.6	0.3	2	0.9
Cladonia uncialis	0.5	0.3	2	0.8
Equisetum hyemale	0.4	0.2	3	0.5
Gaillardia aristata	0.4	0.2	3	0.5
Populus tremuloides	0.4	0.2	3	0.5
Erysimum asperum	0.5	0.1	5	0.5
Festuca hallii	0.3	0.2	2	0.5
Agropyron dasystachyum	0.2	0.2	1	0.4
Juncus balticus	0.2	0.2	1	0.4
Opuntia fragilis	0.2	0.2	1	0.4
Anemone patens	0.2	0.1	2	0.3
Artemisia campestris	0.2	0.1	2	0.3
Chenopodium leptophyllum	0.2	0.1	2	0.3
Agoseris glauca	0.1	0.1	1	0.2
Arabis holboellii	0.1	0.1	1	0.2
Chenopodium album	0.1	0.1	1	0.2
Galium boreale	0.1	0.1	1	0.2
Gaura coccinea	0.1	0.1	1	0.2
Helianthus annuus	0.1	0.1	1	0.2
Kochia scoparia	0.1	0.1	1	0.2
Lepidium densiflorum	0.1	0.1	1	0.2
Poa interior	0.1	0.1	1	0.2
Potentilla hippiana	0.1	0.1	1	0.2
Silene drummondii	0.1	0.1	1	0.2
Viola adunca	0.1	0.1	1	0.2

The *Juniperus horizontalis / Stipa comata - Carex siccata* community was typically found on level to gentle slopes that were at least well drained and subxeric. The soil surface typically had a shallow organic matter accumulation, although small patches of exposed soils were occasionally present. A summary of site data is provided in Table 20.

Table 20. Summary of site data for the *Juniperus horizontalis / Stipa comata - Carex siccata* community type (n = 6).

Plot	Elevation	Slope	Aspect	Drainage	Site Position	Surface Shape	Moisture Regime	Nutrient Regime
7	688	0	n/a	Rapidly	Upper Slope	Convex	Subxeric	Poor
15	695	5	125	Well	Middle Slope	Straight	Subxeric	Medium
22	670	3	348	Well	Middle Slope	Straight	Subxeric	Poor
26	683	0	n/a	Well	Crest	Convex	Subxeric	Medium
32	700	13	230	Well	Lower Slope	Straight	Subxeric	Medium
38	668	16	291	Well	Middle Slope	Concave	Subxeric	Poor

3.6.1 Comparison of *Juniperus horizontalis / Stipa comata - Carex siccata* Community to Literature

A number of communities related to the *Juniperus horizontalis / Stipa comata - Carex siccata* community have been identified in Alberta and are listed in Table 21. A *Juniperus horizontalis* community was found in the Central Parkland in Dillberry Lake Provincial Park. At this location it occurred on steep, northeast and south facing slopes that were well drained. The parent materials included glaciofluvial and eolian deposits. Associated forbs and grasses included *Heterotheca villosa, Thermopsis rhombifolia, Comandra umbellata, Stipa curtiseta, Stipa comata* and *Agropyron trachycaulum* (Meijer and Karpuk 1999). A *Juniperus horizontalis – Selaginella densa – Calamovilfa longifolia* community was documented from the Wainwright Dunes Ecological Reserve, on dry outwash plains, dune complexes and kame moraines (Pearson Timberline 1993). It was described on sites that varied in aspect and slope, although all were rapidly drained with xeric to subxeric moisture regimes. Other low shrubs were occasionally present, including *Rosa* spp. and *Prunus virginiana*, while *Artemisia frigida* and *Festuca hallii* could also be present. A *Juniperus horizontalis / (Koeleria macrantha) / Cladina mitis* community was found in a prior survey of the Wainwright Dunes Ecological Reserve (Fehr 1984). It was generally found on stable blowout areas of sand dunes that had a xeric to very xeric moisture regime and a southerly aspect. Other lichens were noted to also occur in this community. This community is quite similar to that found during the 2003 survey of the Wainwright Dunes Ecological Reserve in terms of site conditions and floristic composition. However, the prominence of lichens suggests that the area sampled in 1984 was more successionally advanced than that surveyed in 2003.

Table 21. Similarity rating for *Juniperus horizontalis / Stipa comata - Carex siccata* community types documented within Alberta.

Similar Communities and Citations	Similarity Rating	Comments
Juniperus horizontalis (Meijer and Karpuk 1999)	2	This community description has different site characteristics, although species composition is quite similar.
Juniperus horizontalis – Selaginella densa – Calamovilfa longifolia (Pearson Timberline 1993)	2	This community description has more variable site characteristics and a different species composition than what was observed in 2003.
Juniperus horizontalis / (Koeleria macrantha) / Cladina mitis (Wheatley and Bentz 2002; Fehr 1984)	2	While the site characteristics between the two communities are quite similar, some of the species and the prominence of these species are different.

Outside of Alberta, there are numerous reports of *Juniperus horizontalis*-dominated communities and they are listed in Table 22. Hulett *et al.* (1966) documented two similar community types and these included (1) *Juniperus horizontalis / Carex heliophila – Selaginella densa* community in stabilized blowouts and (2) a *Juniperus horizontalis – Symphoricarpos occidentalis – Populus tremuloides / Carex heliophila – Agropyron spp. – Stipa comata* in the Dundurn and Great Sandhills in Saskatchewan. *Stipa comata* is noted to be present in the first community type, although it was not a dominant species. Hulett noted that the second community type had 84% cover of *Juniperus horizontalis* on average, with *Populus tremuloides* occurring in small groves. Looman (1983) noted *Juniperus horizontalis* communities described from the Canadian Prairie Provinces where it occurred on east-trending slopes. Looman noted that the juniper provided a ground cover of 70-80% but it was not a common community. There was little description provided as to the species composition of this community.

Table 22. Similarity rating for *Juniperus horizontalis / Stipa comata - Carex siccata* community types documented outside Alberta.

Similar Communities and Citations	Similarity Rating	Comments
Juniperus horizontalis / Carex heliophila – Selaginella densa (Hulett et al. 1966)	2	This community shares some floristic similarities with the Wainwright community but the site characteristics are quite different.
Juniperus horizontalis – Symphoricarpos occidentalis – Populus tremuloides / Carex heliophila – Agropyron spp. – Stipa comata (Hulett et al. 1966)	1	This community shares many floristic similarities with the Wainwright community and quite similar site conditions.
Juniperus horizontalis communities (Looman 1983)	2	There is little description provided as to the species composition of this community, and there are some differences in the site conditions.
Juniperus horizontalis / Carex inops ssp. heliophila Dwarf-shrubland (NatureServe 2003; MNHP 2002:Faber-Langendoen 2001; Schneider *et al.* 1997)	2	This community shares some floristic similarities although the site characteristics are quite different.
Juniperus horizontalis / Carex heliophila (Hansen and Hoffman 1988)	3	This community shares some floristic similarities although the site characteristics are quite different.
Juniperus horizontalis / Schizachyrium scoparium Dwarf-shrubland (Faber-Langendoen 2001; Marriott and Faber-Langendoen 2000; Schneider *et al.* 1997)	2	This community shares some floristic similarities although the site characteristics are quite different.
Juniperus horizontalis - Arctostaphylos uva-ursi - Juniperus communis Dune Dwarf-shrubland (NatureServe 2003; Faber-Langendoen 2001)	3	This community, while sharing some floristic similarities, has different site conditions than that observed in Wainwright.

In the northwestern Great Plains of the United States, several authors documented a *Juniperus horizontalis / Carex inops ssp. heliophila* community ranging from southeastern Montana to South Dakota (NatureServe 2003; MNHP 2002; Faber-Langendoen 2001; Schneider *et al.* 1997). This community type was typically found on moderate to steep (35-80%) north-facing slopes, on sandy loam soils. This community was dominated *Juniperus horizontalis* although other species, such as *Artemisia frigida* and *Symphoricarpos occidentalis* were present though not abundant. Grasses and sedges were abundant, particularly *Carex inops* ssp. *heliophila,* although *Schizachyrium scoparium, Carex filifolia, Koeleria macrantha* and *Elymus lanceolatus* were also present. Common forbs included *Campanula rotundifolia, Thermopsis rhombifolia, Anemone patens, Galium boreale* and *Dalea purpurea* (Faber-Langendoen 2001; Schneider *et al.* 1997). Also, Hansen and Hoffman (1988) described a *Juniperus horizontalis / Carex heliophila* community type is documented from the Custer National Forest in Montana and South Dakota, where it occurred on steep, north-facing slopes. Other than the dominant species, *Andropogon scoparius, Carex filifolia, Thermopsis rhombifolia, Koeleria macrantha, Agropyron dasystachyum, Anemone patens* and *Petalostemon purpureum* were common species. This community was typically found on sandy loams.

Several authors noted a *Juniperus horizontalis / Schizachyrium scoparium* dwarf-shrubland community type is described from the northwestern Great Plains in Canada and the U.S. ranging from Montana and South Dakota to North Dakota and southern Manitoba (Faber-Langendoen 2001; Marriott and Faber-Langendoen 2000; Schneider *et al.* 1997). This community typically occurred on moderate to steep slopes, usually in an upper slope position. Generally this community had a north to west-facing aspect although in Manitoba it was documented on dry south-facing slopes. Soils were silty loams, sandy loams, or clay loams and short shrubs and graminoids dominated this community. *Juniperus horizontalis* was the dominant dwarf shrub although other species including *Artemisia frigida, Symphoricarpos occidentalis, Rosa arkansana, Rhus trilobata and Prunus virginiana* were present. *Schizachyrium scoparium* was noted to be the dominant graminoid, although *Calamovilfa longifolia, Carex filifolia, Carex inops ssp. heliophila, Carex eleocharis, Koeleria macrantha, and Muhlenbergia cuspidata* were also common. Bare ground occupied 25-45% of the ground surface cover.

Several authors also noted a *Juniperus horizontalis – Arctostaphylos uva-ursi – Juniperus communis* community from the U.S. Midwest, where it is found on flat-topped, wind-swept, stabilized dunes (NatureServe 2003; Faber-Langendoen 2001). It was found throughout the dune areas of the western Great Lakes region, of the U.S. and Canada, ranging from the shores of southern Michigan, Illinois, Indiana and Michigan, north to the shores of other Great Lakes such as Superior in Wisconsin. The community was typically an open to closed dwarf-shrub mat. *Hudsonia tomentosa* was also present, along with various deciduous shrubs. *Ammophila breviligulata* and *Schizachiyrium scoparium* were noted to be the dominant herbaceous species.

3.6.2 Preliminary Conservation Ranking of *Juniperus horizontalis / Stipa comata - Carex siccata* Community

Preliminary Rank: ***S3S4***

A *Juniperus horizontalis – Selaginella densa – Calamovilfa longifolia* community was previously documented from the Wainwright Dunes Ecological Reserve, on dry outwash plains, dune complexes and kame moraines and was given a preliminary rank of S4 (Wheatley and Bentz 2002; Pearson Timberline 1993). It was described on sites that varied in aspect and slope, although all were rapidly drained with xeric to subxeric moisture regimes. This community shares some of the same site characteristics, however the species composition is notably different.

There have also been numerous reports documenting *Juniperus horizontalis*–dominated communities, as a pioneer or early successional community on bare sand. However, this community observed in the Wainwright Dunes area is well established with minimal exposed sand at the surface. While this community is likely restricted to eolian landscapes, it was found to be quite widespread through the Wainwright Dunes Ecological Reserve. As such a preliminary rank of **S3S4** is suggested for this community type, although additional sampling in eolian landscapes in other areas of the province may help to clarify its full geographic extent.

3.7 *Juniperus horizontalis / Calamovilfa longifolia - Carex pensylvanica ssp. heliophila Association*

Creeping juniper / sand grass – sun-loving sedge

Plate 5. *Juniperus horizontalis / Calamovilfa longifolia - Carex pensylvanica ssp. heliophila* (Creeping juniper / sand grass – sun-loving sedge) Plot 13.

The *Juniperus horizontalis / Calamovilfa longifolia - Carex pensylvanica ssp. heliophila* community was very limited in extent, being found on partially stabilized dunes. *Juniperus horizontalis* dominates the low shrub stratum, with *Calamovilfa longifolia* and *Carex pensylvanica* ssp. *heliophila* co-dominating the graminoid stratum. *Sporobolus cryptandrus* was present in the majority of sites surveyed with a mean cover of approximately 8 %, however it was not found at all sites. Other common graminoids included *Carex siccata, Stipa comata* and *Koeleria macrantha*, though typically with covers less than 10 %. *Artemisia frigida, Prunus virginiana, Cladina mitis* and *Heterotheca villosa* were also relatively common species, though with relatively low percent covers. Table 23 summarizes the species composition, mean percent cover, standard error and species prominence for this community type.

Table 23. Summary statistics for the *Juniperus horizontalis / Calamovilfa longifolia - Carex pensylvanica ssp. heliophila* community type (n = 3).

Species	Mean % Cover	Standard Error	Presence	Prominence
Calamovilfa longifolia	19.0	6.7	3.0	19.0
Juniperus horizontalis	17.3	5.4	3.0	17.3
Sporobolus cryptandrus	8.3	6.0	2.0	10.2
Carex pensylvanica ssp. heliophila	7.0	4.2	3.0	7.0
Carex siccata	5.7	2.3	3.0	5.7
Artemisia frigida	5.3	4.8	3.0	5.3
Stipa comata	4.0	1.0	3.0	4.0
Koeleria macrantha	4.0	1.0	3.0	4.0
Selaginella densa	1.7	1.7	1.0	2.9
Arctostaphylos uva-ursi	1.7	1.7	1.0	2.9
Prunus virginiana	2.5	0.9	3.0	2.5
Cladina mitis	2.3	0.3	3.0	2.3
Chamaerhodos erecta	1.7	0.9	2.0	2.0
Solidago spathulata	0.7	0.7	1.0	1.2
Chenopodium pratericola	0.7	0.7	1.0	1.2
Carex filifolia	1.0	0.6	2.0	1.2
Populus tremuloides	0.8	0.4	2.0	1.0
Heterotheca villosa	1.0	0.0	3.0	1.0
Rosa arkansana	0.5	0.3	2.0	0.6
Kochia scoparia	0.3	0.3	1.0	0.6
Festuca saximontana	0.5	0.3	2.0	0.6
Cladonia uncialis	0.3	0.3	1.0	0.6
Chenopodium leptophyllum	0.3	0.2	2.0	0.4
Thermopsis rhombifolia	0.2	0.2	1.0	0.3
Erysimum asperum	0.2	0.2	1.0	0.3
Equisetum hymenale	0.2	0.2	1.0	0.3
Descurainia sophia	0.2	0.2	1.0	0.3
Artemisia ludoviciana	0.2	0.2	1.0	0.3
Artemisia campestris	0.2	0.2	1.0	0.3

When present, this community was found on strong south to southwest facing dune slopes, where some active sand movement was present. All sites had between 20-35 % exposed sand, with the remainder having organic matter or vegetative cover. This subxeric community was typically in a mid-slope position with a straight to convex surface shape. A summary of site data is provided in Table 24.

Table 24. Summary of site data for the *Juniperus horizontalis / Calamovilfa longifolia - Carex pensylvanica ssp. heliophila* community type (n = 3).

Plot	Elevation	Slope	Aspect	Drainage	Site Position	Surface Shape	Moisture Regime	Nutrient Regime
13	688	38	243	Rapidly	Middle Slope	Straight	Subxeric	Poor
14	697	32	186	Rapidly	Middle Slope	Convex	Subxeric	Poor
16	670	22	225	Rapidly	Middle Slope	Straight	Subxeric	Poor

3.7.1 Comparison of *Juniperus horizontalis / Calamovilfa longifolia - Carex pensylvanica* ssp. *heliophila* Community to Literature

Previous studies in the Wainwright Dunes Ecological Reserve and elsewhere in Alberta have identified related community types and these are noted in Table 25. Fehr (1984) described a "stabilized blowout" community type from the Wainwright Dunes Ecological Reserve Canopy. In this community, the cover of the herb-dwarf shrub layer in more stable blowout sites averaged 45%, ranging from 30-60%. Mineral soil cover was approximately 40%. Most plants found were important colonizers of bare sand, including *Carex foenea, Calamovilfa longifolia, Elymus canadensis, Oryzopsis hymenoides, Festuca saximontana*, and *Chrysopsis villosa. Selaginella densa, Carex obtusata,* *Koeleria cristata* and *Juniper horizontalis* were important species in more stable blowouts. Similarly, a *Juniperus horizontalis – Selaginella densa – Calamovilfa longifolia* community was documented from the Wainwright Dunes Ecological Reserve, on dry outwash plains, dune complexes and kame moraines (Pearson Timberline 1993). It was described on sites that varied in aspect and slope, although all were rapidly drained with xeric to subxeric moisture regimes. Other shorter shrubs were occasionally present, including *Rosa* spp. and *Prunus virginiana*, while *Artemisia frigida* and *Festuca hallii* could also be present. A *Juniperus horizontalis / (Koeleria macrantha) / Cladina mitis* community was found in a prior survey of the Wainwright Dunes Ecological Reserve. It was generally found on stable blowout areas of sand dunes that had a xeric to very xeric moisture regime and a southerly aspect. Other lichens were noted to also occur in this community. A *Juniperus horizontalis* community was also found in the Central Parkland in Dillberry Lake Provincial Park. At this location it occurred on steep, northeast and south facing slopes that were well drained. The parent materials included glaciofluvial and eolian deposits. Associated forbs and grasses included *Heterotheca villosa, Thermopsis rhombifolia, Comandra umbellata, Stipa curtiseta, Stipa comata* and *Agropyron trachycaulum*. (Meijer and Karpuk 1999).

Table 25. Similarity rating for *Juniperus horizontalis / Calamovilfa longifolia - Carex pensylvanica ssp. heliophila* community types documented within Alberta.

Similar Communities and Citations	Similarity Rating	Comments
Stabilized blowout (Fehr 1984)	1	This community description fits with the observed site characteristics with few differences in species composition.
Juniperus horizontalis – Selaginella densa – Calamovilfa longifolia (Pearson Timberline 1993)	2	This community description has more variable site characteristics and a different species composition than what was observed in 2003.
Juniperus horizontalis / (Koeleria macrantha) / Cladina mitis (Allen 2003; Wheatley and Bentz 2002; Fehr 1984)	1	While some of the species are different between these two communities, the site characteristics between the two are quite similar and likely represent the same community.
Juniperus horizontalis (Meijer and Karpuk 1999)	2	This community describes similar site characteristics, but the species composition slightly different.

Outside Alberta a number of related community types have been documented and these are listed in Table 26. Hulett *et al.* (1966) documented two similar community types and these included (1) *Juniperus horizontalis / Carex heliophila – Selaginella densa* community in stabilized blowouts and (2) a *Juniperus horizontalis – Symphoricarpos occidentalis – Populus tremuloides / Carex heliophila – Agropyron spp. – Stipa comata* in the Dundurn and Great Sandhills in Saskatchewan. *Stipa comata* is noted to be present in the first community type, although it was not a dominant species. Hulett noted that the second community type had 84% cover of *Juniperus horizontalis* on average, with *Populus tremuloides* occurring in small groves. Looman (1983) noted *Juniperus horizontalis* communities described from the Canadian Prairie Provinces where it occurred on east-trending slopes. Looman noted that the juniper provided a ground cover of 70-80% but it was not a common community. There was little description provided as to the species composition of this community.

In the northwestern Great Plains of the United States, several authors documented a *Juniperus horizontalis / Carex inops ssp. heliophila* community ranging from southeastern Montana to South Dakota (NatureServe 2003; MNHP 2002; Faber-Langendoen 2001; Schneider *et al.* 1997). This community type was typically found on moderate to steep (35-80%) north-facing slopes, on sandy loam soils. This community was dominated *Juniperus horizontalis* although other species, such as *Artemisia frigida* and *Symphoricarpos occidentalis* were present though not abundant. Grasses and sedges were abundant, particularly *Carex inops* ssp. *heliophila*, although *Schizachyrium scoparium, Carex filifolia, Koeleria macrantha* and *Elymus lanceolatus* were also present. Common forbs included *Campanula rotundifolia, Thermopsis rhombifolia, Anemone patens, Galium boreale* and *Dalea purpurea* (Faber-Langendoen 2001; Schneider *et al.* 1997). Also, Hansen and Hoffman (1988) described a *Juniperus horizontalis / Carex heliophila* community type is documented from the Custer National Forest in Montana and South Dakota, where it occurred on steep, north-facing slopes. Other than the dominant species, *Andropogon scoparius, Carex filifolia, Thermopsis rhombifolia, Koeleria macrantha, Agropyron dasystachyum, Anemone patens* and *Petalostemon purpureum* were common species. This community was typically found on sandy loams.

Several authors noted a *Juniperus horizontalis / Schizachyrium scoparium* dwarf-shrubland community type is described from the northwestern Great Plains in Canada and the U.S. ranging from Montana and South Dakota to North Dakota and southern Manitoba (Faber-Langendoen 2001; Marriott and Faber-Langendoen 2000; Schneider *et al.* 1997). This community typically occurred on moderate to steep slopes, usually in an upper slope position. Generally this community had a north to west-facing aspect although in Manitoba it was documented on dry south-facing slopes. Soils were silty loams, sandy loams, or clay loams and short shrubs and graminoids dominated this community. *Juniperus horizontalis* was the dominant dwarf shrub although other species including *Artemisia frigida, Symphoricarpos occidentalis, Rosa arkansana, Rhus trilobata and Prunus virginiana* were present. *Schizachyrium scoparium* was noted to be the dominant graminoid, although *Calamovilfa longifolia, Carex filifolia, Carex inops ssp. heliophila, Carex eleocharis, Koeleria macrantha, and Muhlenbergia cuspidata* were also common. Bare ground occupied 25-45% of the ground surface cover.

Table 26. Similarity rating for *Juniperus horizontalis / Calamovilfa longifolia - Carex pensylvanica ssp. heliophila* community types documented outside Alberta.

Similar Communities and Citations	Similarity Rating	Comments
Juniperus horizontalis / Carex heliophila – Selaginella densa (Hulett et al. 1966)	1	This community was found in stabilized blowouts in the Dundurn and Great Sandhills in Saskatchewan. *Calamovilfa longifolia* is noted to be common, though not dominant, species. This community shares many floristic similarities with the Wainwright community and the site characteristics are quite similar as well.
Juniperus horizontalis – Symphoricarpos occidentalis – Populus tremuloides / Carex heliophila – Agropyron spp. – Stipa comata (Hulett et al. 1966)	3	This community, while sharing some floristic similarities, has different site conditions than that observed in Wainwright.
Juniperus horizontalis communities (Looman 1983)	2	There is little description provided as to the species composition of this community, and there are some differences in the site conditions.
Juniperus horizontalis / Carex inops ssp. heliophila Dwarf-shrubland (NatureServe 2003; MNHP 2002;Faber-Langendoen 2001; Schneider *et al.* 1997)	1	This community shares many floristic similarities although some of the site characteristics are slightly different.
Juniperus horizontalis / Carex heliophila (Hansen and Hoffman 1988)	2	This community shares numerous floristic similarities although the site characteristics are slightly different.
Juniperus horizontalis / Schizachyrium scoparium Dwarf-shrubland (Faber-Langendoen 2001; Marriott and Faber-Langendoen 2000; Schneider *et al.* 1997)	2	This community shares some floristic similarities but matches the site characteristics documented from Wainwright.
Juniperus horizontalis - Arctostaphylos uva-ursi - Juniperus communis Dune Dwarf-shrubland (NatureServe 2003; Faber-Langendoen 2001)	3	This community is similar in that it's found on sand dunes, however the floristic composition is notably different.

A *Juniperus horizontalis – Arctostaphylos uva-ursi – Juniperus communis* community has been identified from the U.S. Midwest by several authors, where it is found on flat-topped, wind-swept, stabilized dunes (NatureServe 2003; Faber-Langendoen 2001). It was found throughout the dune areas of the western Great Lakes region, of the U.S. and Canada, ranging from the shores of southern Michigan, Illinois, Indiana and Michigan, north to the shores of other Great Lakes such as Superior in Wisconsin. The community was typically an open to closed dwarf-shrub mat. *Hudsonia tomentosa* was also present, along with various deciduous shrubs. *Ammophila breviligulata* and *Schizachiyrium scoparium* were noted to be the dominant herbaceous species.

3.7.2 Preliminary Conservation Ranking of *Juniperus horizontalis / Calamovilfa longifolia - Carex pensylvanica ssp. heliophila* Community

Preliminary Rank: ***S3?***

The main limitation to the occurrence of this community is the availability and size of appropriate habitat, namely recently active sand dunes and blowouts. As such, there is a significant limitation to the expected distribution of this community type within the Central Parkland Natural Subregion. However, there is not a significant amount of information available regarding this community type. A preliminary rank of **S3?** is suggested for this community type and additional sampling of sand dune and sandplain habitats would be beneficial for clarifying the status and geographic extent of this community type.

3.8 *Populus balsamifera / Corylus cornuta - Cornus stolonifera / Aralia nudicaulis* Association

Balsam poplar / beaked hazelnut – red-osier dogwood / wild sarsaparilla

Plate 6. *Populus balsamifera / Corylus cornuta - Cornus stolonifera / Aralia nudicaulis* community type (Balsam poplar / beaked hazelnut – red-osier dogwood / wild sarsaparilla) Plot 4.

The *Populus balsamifera / Corylus cornuta - Cornus stolonifera / Aralia nudicaulis* community was quite limited in extent, occurring in lower or toe slope positions where seasonal moisture or seepage was present. *Populus balsamifera* dominated this community although understorey shrub cover was very high, typically exceeding 100% when combining the low, mid and tall shrub strata. *Corylus cornuta* was the dominant understorey shrub, with *Cornus stolonifera, Viburnum opulus, Rosa acicularis, Salix bebbiana, Ribes oxyacanthoides, Symphoricarpos occidentalis* and *Lonicera dioica* also relatively common though with lower percent coverages. *Aralia nudicaulis* was the dominant forb with approximately 10 % cover, although *Rubus pubescens, Thalictrum venulosum, Lathyrus ochroleucus, Aster ciliolatus, Smilacina stellata* and *Disporum trachycarpum* were also present. Table 27 summarizes the species composition, mean percent cover, standard error and species prominence for this community type.

Table 27.Summary statistics for the *Populus balsamifera / Corylus cornuta - Cornus stolonifera / Aralia nudicaulis* community type (n = 2).

Species	Mean % Cover	Standard Error	Presence	Prominence
Populus balsamifera	30.3	5.5	2	30.3
Corylus cornuta	17.3	9.0	2	17.3
Cornus stolonifera	10.7	9.0	2	10.7
Aralia nudicaulis	10.0	0.0	2	10.0
Viburnum opulus	9.0	11.5	2	9.0
Rosa acicularis	4.0	1.0	2	4.0
Salix bebbiana	4.0	4.0	2	4.0
Populus tremuloides	4.7	5.0	2	3.8
Ribes oxyacanthoides	2.4	3.4	2	2.4
Rubus pubescens	2.3	1.5	2	2.3
Thalictrum venulosum	2.3	1.5	2	2.3
Lathyrus ochroleucus	1.3	1.0	2	1.3
Aster ciliolatus	1.0	1.4	2	1.0
Linnea borealis	1.0	0.5	2	1.0
Symphoricarpos occidentalis	1.0	0.5	2	1.0
Betula occidentalis	0.7	1.0	1	0.9
Symphoricarpos albus	0.7	1.0	1	0.9
Viola canadensis	0.7	1.0	1	0.9
Shepherdia candensis	0.9	1.2	2	0.9
Lonicera dioica	0.8	0.8	2	0.8
Oryzopsis asperifolia	0.7	0.0	2	0.7
Pyrola asarifolia	0.5	0.3	2	0.5
Amelanchier alnifolia	0.3	0.5	1	0.5
Maianthemum candense	0.3	0.5	1	0.5
Rubus idaeus	0.3	0.5	1	0.5
Smilacina stellata	0.4	0.4	2	0.4
Epilobium angustifolium	0.2	0.3	1	0.2
Gallium triflorum	0.2	0.3	1	0.2
Ribes triste	0.2	0.3	1	0.2
Disporum trachycarpum	0.2	0.2	2	0.2
Sanicula mariandica	0.2	0.2	2	0.2
Gallium boreale	0.0	0.1	1	0.0

This community type was found on lower gentle to level slope positions, with a subhygric moisture regime and rich (permesotrophic) nutrient regime. Both sites had significant organic matter (well-humified) accumulation over a sandy, mineral substrate and decaying wood at the soil surface was typical. A summary of site data is provided in Table 28.

Table 28. Summary of site data for the *Populus balsamifera / Corylus cornuta - Cornus stolonifera / Aralia nudicaulis* community type (n = 2).

Plot	Elevation	Slope	Aspect	Drainage	Site Position	Surface Shape	Moisture Regime	Nutrient Regime
4	688	4	186	Well	Lower Slope	Concave	Subhygric	Rich
5	689	0	n/a	Well	Level	Straight	Subhygric	Rich

3.8.1 Comparison of *Populus balsamifera / Corylus cornuta - Cornus stolonifera / Aralia nudicaulis* Community to Literature

Previous studies in the Wainwright Dunes Ecological Reserve and elsewhere in Alberta have identified related community types and these are listed in Table 29. Fehr (1984) documented a balsam poplar community type that was generally located in lower slopes or depressional site positions and had a well-developed tree layer. Balsam poplar was dominant though stands often had an aspen component. The understorey typically had two well-developed shrub layers including willow, *Viburnum trilobum, Cornus stolonifera, Rosa acicularis, Symphoricarpos albus, Ribes* spp. and *Corylus cornuta*. There was also a well-developed herb layer, including *Aralia nudicaulis*, *Thalictrum venulosum*, *Rubus pubescens* and *Aster ciliolatus*. Wheatley and Bentz (2002) described a *Populus balsamifera / Viburnum opulus – Cornus stolonifera / Aralia nudicaulis* community type from the Central Parkland subregion. This community was noted to have a consistently well-developed *Populus balsamifera* layer, with understorey shrub cover averaging 60%. Understorey species included *Cornus stolonifera*, *Populus tremuloides*, *Rosa acicularis*, *Symphoricarpos occidentalis*, and shade tolerant species such as *Aralia nudicaulis*, *Thalictrum venulosum*, *Rubus pubescens*, and *Aster ciliolatus*.

Several balsam poplar community types have been described from the Boreal Mixedwood (Dry and Central Mixedwood) and Foothills regions of Alberta, specifically a balsam poplar / dogwood and a balsam poplar / bracted honeysuckle community type (Beckingham and Archibald 1996; Beckingham *et al.* 1996). Both communities had a subhygric moisture regime and were nutrient rich. These sites tended to be found in lower slope positions and typically had fine textured soils. Common understorey species included: *Cornus stolonifera*, *Lonicera involucrata*, *Salix*. *spp.*, *Aralia nudicaulis* and *Rubus pubescens*. The same authors also documented a balsam poplar / horsetail community type (Beckingham and Archibald 1996; Beckingham *et al.* 1996) from the Boreal Mixedwood and foothills subregions. This community typically had a subhygric to hygric moisture regime and was nutrient rich. It was commonly found on fine textured materials where flooding or seepage occurred. Common understorey species include *Salix* spp., *Rosa acicularis*, *Cornus stolonifera*, *Equisetum arvense*, *E. pratense* and *Calamagrostis canadensis*.

Table 29. Similarity rating for *Populus balsamifera / Corylus cornuta - Cornus stolonifera / Aralia nudicaulis* community types documented within Alberta.

Similar Communities and Citations	Similarity Rating	Comments
Balsam poplar community type (Fehr 1984)	1	This community is the same in terms of site characteristics, stand structure and species composition.
Populus balsamifera / Viburnum opulus – Cornus stolonifera / Aralia nudicaulis (Wheatley and Bentz 2002)	1	This community is the same in terms of site characteristics, stand structure and species composition.
Balsam poplar / dogwood (Beckingham and Archibald 1996) Balsam poplar / bracted honeysuckle (Beckingham *et al.* 1996)	2	These communities are quite similar floristically to that found at Wainwright, however the site characteristics are somewhat different.
Balsam poplar / horsetail (Beckingham and Archibald 1996; Beckingham *et al.* 1996)	3	These communities are somewhat similar floristically to that found at Wainwright, however the site characteristics are quite different.

Few related community types have been recorded outside of Alberta, as shown in Table 30. Thorpe and Godwin (1993) described a *Populus balsamifera* moist community type that community was characterized by balsam poplar forests found on moderately well to poorly drained sandy and clay loam in the Manito Sandhills of Saskatchewan. Common species included *Symphoricarpos occidentalis*, *Salix spp.*, *Rosa spp.*, *Cornus stolonifera*, *Rubus strigosus*, *Aralia nudicaulis*, *Pyrola asarifolia*, *Smilacina stellata* and *Carex species*. NatureServe (2003) documented two balsam poplar community types, although these involve a different subspecies (i.e. ssp. *trichocarpa*).

Table 30. Similarity rating for *Populus balsamifera / Corylus cornuta - Cornus stolonifera / Aralia nudicaulis* community types documented outside Alberta.

Similar Communities and Citations	Similarity Rating	Comments
Populus balsamifera Moist Community Type (Thorpe and Godwin 1993)	1	This community has quite a similar species composition and very similar site conditions.

3.8.2 Preliminary Conservation Ranking of *Populus balsamifera / Corylus cornuta - Cornus stolonifera / Aralia nudicaulis* Community

Preliminary Rank: ***S5***

Populus balsamifera dominated communities are widespread throughout Alberta and other jurisdictions, though they typically do not cover large areas. Specifically, *Populus balsamifera / Corylus cornuta - Cornus stolonifera / Aralia nudicaulis* communities are well-known types from the Central and Dry Mixedwood subregions (Beckingham and Archibald 1996) as well as the Lower and Upper Foothills subregions (Beckingham *et al.* 1996). The main limitations to the occurrence of this community type are the availability of moisture and nutrients. While the communities described from Wainwright occur on a sandy substrate, this is not a restriction to the distribution of this community. These communities do not tend to have very large sizes where they occur, however they are quite common when the edaphic conditions are right.

A preliminary rank of **S5** is suggested for this community type, as it appears to be quite widespread.

3.9 *Populus tremuloides / Juniperus horizontalis / Carex siccata* Association

Aspen / creeping juniper / hay sedge

Plate 7. *Populus tremuloides / Juniperus horizontalis / Carex siccata* community type (Aspen / creeping juniper / hay sedge) Plot 2.

The *Populus tremuloides / Juniperus horizontalis / Carex siccata* community covered an extensive area, and occurred throughout the Wainwright Dunes Ecological Reserve. It generally occurred in a mosaic-type pattern with small open areas of the *Stipa comata – Artemisia frigida – Selaginella densa* community (see section 3.14). *Populus tremuloides* was dominant, both in the overstorey or occurring as a tall shrub. In many instances, *P. tremuloides* had quite a 'scrubby' appearance and was stunted in size. *Juniperus horizontalis* was the dominant shrub, occurring in all the sites sampled. Occasionally other shrub species, such as *Prunus virginiana, Rosa acicularis*, and *Arctostaphylos uva-ursi* were encountered however they did not occur at all sites, and typically had less than 5 % cover. Forb species such as *Solidago missouriensis, Lathyrus ochroleucus, Chenopodium pratericola* and *Galium boreale* were encountered, but none were prominent in the sites sampled. Graminoids typically formed the dominant understorey, with *Carex siccata* having the highest cover; typically around 30 %. Other species, including *Poa pratensis, Calamovilfa longifolia, Festuca saximontana, Koeleria macrantha*, and *Schizachne purpurescens* were common at most sites however they typically had relatively low percent covers. Table 31 summarizes the species composition, mean percent cover, standard error and species prominence for this community type.

Table 31. Summary statistics for the *Populus tremuloides / Juniperus horizontalis / Carex siccata* community type (n = 5).

Species	Mean % Cover	Standard Deviation	Standard Error	Presence	Prominence
Populus tremuloides	37.2	10.0	4.5	5	37.2
Carex siccata	30.0	21.8	9.7	5	30.0
Juniperus horizontalis	16.4	8.4	3.7	5	16.4
Poa pratensis	6.6	13.1	5.9	3	8.5
Arctostaphylos uva-ursi	5.4	6.8	3.0	3	7.0
Spirea alba	2.0	2.7	1.2	2	3.2
Solidago missouriensis	2.4	2.5	1.1	3	3.1
Calamovilfa longifolia	2.7	4.1	1.9	4	3.0
Carex pensylvanica ssp. heliophila	1.6	2.3	1.0	2	2.5
Festuca saximontana	2.2	2.8	1.2	4	2.5
Rosa acicularis	1.9	2.1	0.9	3	2.5
Oryzopsis asperifolia	1.0	2.2	1.0	1	2.2
Selaginella densa	1.4	2.2	1.0	2	2.2
Koeleria macrantha	1.6	2.1	0.9	4	1.8
Cladina mitis	1.0	1.4	0.6	2	1.6
Prunus virginiana	1.1	1.0	0.5	3	1.4
Schizachne purpurescens	0.8	0.8	0.4	3	1.0
Lathyrus ochroleucus	0.6	0.9	0.4	2	0.9
Comandra umbellata	0.4	0.9	0.4	1	0.9
Stipa comata	0.4	0.9	0.4	1	0.9
Gallium boreale	0.6	0.5	0.2	3	0.8
Chenopodium pratericola	0.5	0.5	0.2	3	0.6
Artemisia ludoviciana	0.4	0.5	0.2	2	0.6
Festuca hallii	0.4	0.5	0.2	2	0.6
Solidago spathulata	0.4	0.5	0.2	2	0.6
Viola adunca	0.4	0.4	0.2	3	0.5
Thermopsis rhombifolia	0.3	0.4	0.2	2	0.5
Agrostis scabra	0.2	0.4	0.2	1	0.4
Anemone multifida	0.2	0.4	0.2	1	0.4
Aster ciliolatus	0.2	0.4	0.2	1	0.4
Cladonia uncialis	0.2	0.4	0.2	1	0.4
Descurainia sophia	0.2	0.4	0.2	1	0.4
Heterotheca villosa	0.2	0.4	0.2	1	0.4
Poa interior	0.2	0.4	0.2	1	0.4
Populus balsamifera	0.2	0.4	0.2	1	0.4
Rosa arkansana	0.2	0.4	0.2	1	0.4
Salix bebbiana	0.2	0.4	0.2	1	0.4
Symphoricarpos albus	0.2	0.4	0.2	1	0.4
Chenopodium leptophyllum	0.2	0.4	0.2	2	0.3
Erigeron glabellus	0.2	0.3	0.1	2	0.3
Agoseris glauca	0.1	0.2	0.1	1	0.2
Arabis holboellii	0.1	0.2	0.1	1	0.2
Chenopodium album	0.1	0.2	0.1	1	0.2
Heuchera richardsonii	0.1	0.2	0.1	1	0.2
Equisetum hymenale	0.1	0.2	0.1	2	0.2

This community was generally found on level to gently sloping (less than 5 %) sand plains that were typically well drained. The ground surface had a relatively shallow accumulation of organic materials, with some decaying wood. A summary of site data is provided in Table 32.

Table 32. Summary of site data for the *Populus tremuloides / Juniperus horizontalis / Carex siccata* community type (n = 5).

Plot	Elevation	Slope	Aspect	Drainage	Site Position	Surface Shape	Moisture Regime	Nutrient Regime
2	687	4	188	Well	Middle Slope	Straight	Submesic	Poor
6	685	0	n/a	Well	Crest	Convex	Submesic	Medium
17	670	4	27	Well	Middle Slope	Straight	Subxeric	Medium
23	670	0	n/a	Well	Toe	Concave	Submesic	Medium
37	670	0	n/a	Moderately Well	Depression	Concave	Submesic	Medium

3.9.1 Comparison of *Populus tremuloides / Juniperus horizontalis / Carex siccata* Community to Literature

Previous studies in the Wainwright Dunes Ecological Reserve and elsewhere in Alberta have identified related community types and these are listed in Table 33. Fehr, in a 1984 survey of the Wainwright Dunes Ecological Reserve, documented a subxeric to submesic aspen community found on sand flats or undulating plain and on dunes. Communities had well-developed aspen canopy (57.6% cover) but not a well-developed low shrub layer. The herb-dwarf shrub layer averaged 57.5% cover with *Carex foenea, Thermopsis rhombifolia, Galium boreale, Lathyrus ochroleucus, Smilacina stellata* and *Juniperus horizontalis* as the dominant species in this layer. A *Populus tremuloides / Juniperus horizontalis / Cladina mitis* community has been described from the Central Parkland in the Wainwright Dunes Ecological Reserve as well as at Dillberry Lake Provincial Park (Meijer and Karpuk 1999). In both cases, the community was described as having a short aspen overstorey (2 m) with approximately 20% cover of *Juniperus horizontalis*. This community was typically found in interdune depressions or upper slope positions of short, south-facing slopes. Generally sites were xeric and rapidly drained. Associated species often included *Rosa acicularis, Salix bebbiana, Artemisia campestris, Selaginella densa* and *Calamovilfa longifolia*. While this community was quite similar floristically, it is structurally somewhat different that observed in the 2003 Wainwright survey. A *Populus tremuloides /* (sparse understorey) community was described from the Central Parkland subregion, where it was found on depressional sites as well as gently to moderately sloping sites with a northerly to southerly aspect. The community consists of young (<30 years old) aspen, with little or no understorey growth. While the scrubby aspen community in the sand flats of the Ecological Reserve is quite young, they do tend to have a somewhat developed understorey, at least as far as dwarf-shrub and graminoids are concerned. A *Populus tremuloides / Juniperus horizontalis* community was described from Dillberry Lake Provincial Park on a shallow, south-facing slope that was rapidly drained (Meijer and Karpuk 1999). It was considered to be subxeric, and associated species included *Solidago missouriensis, Calamovilfa longifolia, Carex obtusata* and *Cladina mitis*. Additional *Populus tremuloides* communities have been documented for Alberta and the most relevant types are documented and assessed in Table 22. Many other *Populus tremuloides*-dominated community types have been described for Alberta, however most do not share many site or floristic characteristics and thus have not been discussed.

Various related community types have been recorded outside of Alberta and they are listed in Table 34. Thorpe and Godwin (1993) described a *Populus tremuloides* sand type from the Manito Sandhills in Saskatchewan. This community was characterized by aspen forests found on upland, north-facing or lower slope positions as well as on more stabilized landforms. This community was found to be most widespread occurring community type in Manito Sandhills. The authors also documented a *Populus tremuloides* loam type, forests found on well to moderately well drained sandy loam to clay loam soils. Common species included *Symphoricarpos occidentalis, Rubus strigosus, Amelanchier alnifolia, Rosa woodsii, Galium boreale, Thalictrum venulosum, Fragaria virginiana* and *Carex siccata*. .

A *Populus tremuloides / Corylus spp. / Andropogon gerardii* woodland community has been described from the aspen parkland region of the upper midwestern United States and adjacent Canada, ranging from Minnesota to Manitoba (Faber-Langendoen 2001). This community was typically found on level to rolling terrain. The canopy was typically quite open but this characteristic could vary. *Populus tremuloides* was the dominant overstorey species, although *Populus grandidentata* and *Populus balsamifera* were dominant in certain areas.

Table 33. Similarity rating for *Populus tremuloides / Juniperus horizontalis / Carex siccata* community types documented within Alberta.

Similar Alberta Communities and Citations	Similarity Rating	Comments
Subxeric to submesic aspen (Fehr 1984)	1	This is the same community type in terms of site characteristics, although the species composition is slightly different.
Populus tremuloides / Juniperus horizontalis / Cladina mitis (Meijer and Karpuk 1999; Fehr 1984)	2	While this community is quite similar floristically, it is structurally somewhat different than that observed in the 2003 Wainwright survey. Also, there is no mention of *Carex siccata* as being a dominant species.
Populus tremuloides / (sparse understorey) (Fehr 1982)	2	This community is somewhat similar in site and community composition, but has several distinct differences.
Populus tremuloides / Juniperus horizontalis (Meijer and Karpuk 1999)	2	This community, although sharing a couple dominant species, is structurally and floristically quite different from that found in the 2003 Wainwright survey.

The shrub/sapling layer was usually well developed and included *Amelanchier alnifolia, Corylus americana, Cornus foenea, Prunus virginiana, Rosa spp.*, and *Rubus* spp. On wetter sites, associated species included *Betula pumila, Cornus sericea, Salix bebbiana*, and *Spiraea alba*. Although this community is an aspen parkland community type, it has quite a different floristic composition than that found in Wainwright. A number of authors document a *Populus tremuloides / Prunus virginiana* forest community type from the Rocky Mountains and Black Hills in the western United States (NatureServe 2003; Faber-Langendoen 2001; Marriott and Faber-Langendoen 2000a; Schneider *et al.* 1997). In the Black Hills, this community tended to occur along mesic valley bottoms where slopes varied from steep to gentle. While deciduous trees dominated the community, there a small component of evergreen trees *Picea glauca* (in the Black Hills) and *Pinus ponderosa* could occasionally be found. Common understorey species included *Prunus virginiana, Amelanchier alnifolia, Ribes* spp., and *Symphoricarpos spp.*. Several authors also documented a *Populus tremuloides / Prunus virginiana* woodland community found in the north-central Great Plains of the United States and Canada Woodland (NatureServe 2003; Faber-Langendoen 2001; Schneider *et al.* 1997). In North Dakota, this community occurred on well-drained loam soils. The canopy was moderately dense to dense and was dominated by *Populus tremuloides*, although *Fraxinus pennsylvanica* may be a common associate. The shrub layer was typically very well developed and was dominated by *Prunus virginiana*. Other understorey species included *Amelanchier alnifolia, Corylus spp., Rosa* spp., and *Symphoricarpos occidentalis. Aralia nudicaulis, Maianthemum stellatum*, and *Galium boreale* may be found in the herbaceous layer.

Many other *Populus tremuloides*–dominated community types have been described outside of Alberta, however most do not share many site or floristic characteristics and thus have not been discussed.

Table 34. Similarity rating for *Populus tremuloides / Juniperus horizontalis / Carex siccata* community types documented outside Alberta.

Similar Communities and Citations	Similarity Rating	Comments
Populus tremuloides sand type (Thorpe and Godwin 1993)	2	This community has similar overstorey species, although site conditions are quite different
Populus tremuloides loam type (Thorpe and Godwin 1993)	2	This community has quite a similar species composition though somewhat different site conditions.
Populus tremuloides / Corylus spp. / *Andropogon gerardii* woodland (NatureServe 2003; Faber-Langendoen 2001)	3	This community has different site characteristics and is different floristically than that found in Wainwright
Populus tremuloides / Prunus virginiana Forest (NatureServe 2003; MNHP 2002; Faber-Langendoen 2001; Marriott and Faber-Langendoen 2000; Schneider *et al.* 1997)	3	This community has different site characteristics and is different floristically than that found in Wainwright
Populus tremuloides / Prunus virginiana Woodland (NatureServe 2003; Faber-Langendoen 2001; Schneider *et al.* 1997)	3	This community has different site characteristics and is different floristically than that found in Wainwright

3.9.2 Preliminary Conservation Ranking of *Populus tremuloides / Juniperus horizontalis / Carex siccata* Community

Preliminary Rank: ***S2S3***

This *Populus tremuloides* dominated community was the most unique of the three aspen-dominated communities that were documented at the Wainwright Dunes Ecological Reserve. This community was generally found on level to gently sloping sand plains and covered an extensive area. It generally occurred in a mosaic type pattern with more open areas of the *Artemisia frigida – Selaginella densa – Stipa comata* community. In many instances, *P. tremuloides* had quite a 'scrubby' appearance and was stunted in size. Fehr described a similar community type and distribution in a 1984 inventory of the same area, however similar communities have not been discussed elsewhere in the literature.

As such a preliminary rank of **S2S3** is suggested for this community type. Additional sampling in sand dune and sand plain landscapes outside the Wainwright Dunes Ecological Reserve may help to clarify the status and overall geographic extent of this community type.

3.10 *Populus tremuloides / Prunus virginiana - Amelanchier alnifolia / Carex siccata* Association

Aspen / chokecherry – saskatoon / hay sedge

Plate 8. *Populus tremuloides / Prunus virginiana - Amelanchier alnifolia / Carex siccata* community type (Aspen / chokecherry – saskatoon / hay sedge) Plot 29.

The *Populus tremuloides / Prunus virginiana - Amelanchier alnifolia / Carex siccata* community type was quite common through the Wainwright Dunes Ecological Reserve, though limited in its distribution. It was found on steep, generally northeast facing slopes on the leeward side of dunes. It typically only covered the 7-10 metre long slope, until leveling out into a grassland or more open stand. A very high shrub cover, relatively high grass cover and few forbs characterize this community. *Populus tremuloides* was the dominant species, typically having a cover of around 40 %. Shrub cover was very high, commonly exceeded 50 % cover. The most common shrub species were *Prunus virginiana* and *Amelanchier alnifolia* although *Rosa acicularis, Rhus radicans, Symphoricarpos alba* and *Juniperus horizontalis* were also quite common. *Carex siccata* was the dominant graminoid, with a mean cover of approximately 10 %, however *Elymus canadensis, Poa pratensis, Schizachne purpurescens* were also found. Total forb cover was generally less than 10 %, although the diversity in forb species encountered was quite variable. *Lathyrus ochroleucus, Galium boreale* and *Aster ciliolatus* (likely a subspecies or variety) were found in all sites sampled. Table 35 summarizes the species composition, mean percent cover, standard error and species prominence for this community type.

Table 35. Summary statistics for the *Populus tremuloides / Prunus virginiana - Amelanchier alnifolia / Carex siccata* community type (n = 4).

Species	Mean % Cover	Standard Error	Presence	Prominence
Populus tremuloides	40.6	5.3	4	40.6
Prunus virginiana	22.3	8.8	4	22.3
Amelanchier alnifolia	11.9	5.5	4	11.9
Carex siccata	10.5	5.9	4	10.5
Rosa acicularis	8.0	3.4	3	9.2
Spirea alba	2.8	2.8	1	5.5
Rhus radicans	3.0	2.4	2	4.2
Symphoricarpos albus	3.8	1.7	4	3.8
Oryzopsis asperifolia	1.8	1.8	1	3.5
Juniperus horizontalis	3.3	1.3	4	3.3
Juniperus communis	1.3	1.3	1	2.5
Elymus candensis	1.5	1.2	2	2.1
Poa pratensis	1.5	1.2	2	2.1
Thermopsis rhombifolia	1.0	1.0	1	2.0
Schizachne purpurescens	1.6	1.1	3	1.9
Gallium boreale	1.8	0.3	4	1.8
Arctostaphylos uva-ursi	1.0	0.6	2	1.4
Elaeagnus commutata	0.6	0.6	1	1.3
Lonicera dioica	0.8	0.7	2	1.1
Cladina mitis	0.5	0.5	1	1.0
Comandra umbellata	0.5	0.5	1	1.0
Maianthemum candense	0.5	0.5	1	1.0
Stipa spartea	0.5	0.5	1	1.0
Lathyrus ochroleucus	0.9	0.1	4	0.9
Smilacina stellata	0.8	0.3	3	0.9
Aster ciliolatus	0.8	0.1	4	0.8
Symphoricarpos occidentalis	0.4	0.4	1	0.8
Viola canadensis	0.5	0.3	2	0.7
Aralia nudicaulis	0.3	0.3	1	0.5
Equisetum hymenale	0.3	0.3	1	0.5
Festuca saximontana	0.3	0.3	1	0.5
Juncus balticus	0.3	0.3	1	0.5
Ribes oxyacanthoides	0.3	0.3	1	0.5
Heuchera richardsonii	0.3	0.1	2	0.4
Bromus inermis	0.1	0.1	1	0.3
Disporum trachycarpum	0.1	0.1	1	0.3
Erigeron glabellus	0.1	0.1	1	0.3
Fragaria virginiana	0.1	0.1	1	0.3
Rubus idaeus	0.1	0.1	1	0.3
Solidago candensis	0.1	0.1	1	0.3
Solidago missouriensis	0.1	0.1	1	0.3
Thalictrum venulosum	0.1	0.1	1	0.3
Viola adunca	0.1	0.1	1	0.3

This community was generally found on steep (30 – 60 %) slopes with a northeasterly aspect. The soil surface typically had a shallow accumulation of organic matter, with some decaying wood. Sites were typically well drained, with a submesic moisture regime. A summary of site data is provided in Table 36.

Table 36. Summary of site data for the *Populus tremuloides / Prunus virginiana - Amelanchier alnifolia / Carex siccata* community type (n = 4).

Plot	Elevation	Slope	Aspect	Drainage	Site Position	Surface Shape	Moisture Regime	Nutrient Regime
11	691	34	33	Well	Middle Slope	Straight	Submesic	Medium
25	670	42	65	Well	Middle Slope	Straight	Submesic	Medium
29	692	56	40	Well	Middle Slope	Straight	Submesic	Medium
36	679	0	n/a	Moderately Well	Level	Straight	Submesic	Medium

3.10.1 Comparison of *Populus tremuloides / Prunus virginiana - Amelanchier alnifolia / Carex siccata* Community to Literature

Previous studies in the Wainwright Dunes Ecological Reserve and elsewhere in Alberta have identified related community types, and these are listed in Table 37. Fehr (1984) described a "north-facing dune dense aspen" community type from the Wainwright Dunes Ecological Reserve. This community was located on dunes averaging 32° slope and oriented towards the northeast. The communities had a subxeric to submesic moisture regime but some were more mesic. Overstorey aspen cover ranged from 10-70% but averaged at about 42%. Understorey shrub cover averaged 43% and ranged from 30-60%. The dominant species were *Prunus virginiana, Rosa acicularis, Spirea alba, Prunus pensylvanica* and *Symphoricarpos albus*. A *Populus tremuloides /* (sparse understorey) community was described from the Central Parkland subregion, where it was found on depressional sites as well as gently to moderately sloping sites with a northerly to southerly aspect (Wheatley and Bentz 2002). The community consisted of young (<30 years old) aspen, with little or no understorey growth. While the scrubby aspen community in the sand flats of the Ecological Reserve is quite young, they do tend to have a somewhat developed understorey, at least as far as dwarf-shrub and graminoids are concerned. A *Populus tremuloides / Prunus virginiana* – (Shrub) / Low Herb community has been described from the Central Parkland where it is found several locations. Meijer and Karpuk (1999) described this community from the Dillberry Lake area, where it occurred on upland eolian and glaciofluvial materials, on upper slopes where there was little moisture accumulation. Pearson Timberline (1993) noted this community from the Wainwright Dunes area, where it was found on dry sandy outwash plains, dune complexes, depressions and kame moraines. The slope ranged from 0-70%. Other noted species include: *Amelanchier alnifolia, Symphoricarpos occidentalis, Rosa spp., Juniperus horizontalis, Lathyrus ochroleucus, Schizachne purpurescens, Carex foenea, Thermopsis rhombifolia, Smilacina stellata* and *Galium boreale*. Adams *et al.* (1997) described a *Populus tremuloides / Symphoricarpos occidentalis* community dominated by aspen in the overstorey, with *Symphoricarpos occidentalis, Salix spp.*, and *Betula occidentalis* in the shrub understorey. *Agropyron trachycaulum* was noted to be the dominant graminoid. This community was found on a variety of parent materials, but they were dominantly sandy. Slopes ranged up to 10 % but typically had a southeasterly aspect. Adams *et al.* (1997) also noted a general *Populus tremuloides* community type unfortunately no further information was provided. Many other *Populus tremuloides*–dominated community types have been described for Alberta, however most do not share many site or floristic characteristics and thus have not been discussed.

Various related community types have been recorded outside of Alberta and these are listed in Table 38. Thorpe and Godwin (1993) described a *Populus tremuloides* sand type from the Manito Sandhills in Saskatchewan. This community was characterized by aspen forests found on upland, north-facing or lower slope positions as well as on more stabilized landforms. This community was found to be most widespread occurring community type in Manito Sandhills. The authors also documented a *Populus tremuloides* loam type, forests found on well to moderately well drained sandy loam to clay loam soils. Common species included *Symphoricarpos occidentalis, Rubus strigosus, Amelanchier alnifolia, Rosa woodsii, Galium boreale, Thalictrum venulosum, Fragaria virginiana* and *Carex siccata*.

Table 37. Similarity rating for *Populus tremuloides / Prunus virginiana - Amelanchier alnifolia / Carex siccata* community types documented within Alberta.

Similar Communities and Citations	Similarity Rating	Comments
North-facing dune dense aspen (Fehr 1984)	1	This is the same community type in terms of site characteristics with only a few minor differences in understorey species composition.
Populus tremuloides / (sparse understorey) (Wheatley and Bentz 2002; Fehr 1982)	2	This community is somewhat similar in site characteristics, but has a substantially different species composition and structure.
Populus tremuloides / Prunus virginiana – (Shrub) / Low Herb (Meijer and Karpuk 1999; Fehr 1984; Pearson Timberline 1993)	3	The sites documented in the literature and the species composition and stand structure are quite different than those observed in this type.
Populus tremuloides / Symphoricarpos occidentalis (Adams *et al.* 1997)	3	This community is quite different floristically and in site characteristics than that found in the Wainwright area.
Populus tremuloides (Adams *et al.* 1997)	?	There is no information provided regarding the floristic composition and site characteristics of this community as it is considered to be minor or indistinct community that will be further developed with additional field sampling. As such it is difficult to assess its similarity to the community found in Wainwright.

A number of authors documented a *Populus tremuloides / Prunus virginiana* forest community type from the Rocky Mountains and Black Hills in the western United States (NatureServe 2003; Faber-Langendoen 2001; Marriott and Faber-Langendoen 2000a; Schneider *et al.* 1997). In the Black Hills, this community tended to occur along mesic valley bottoms where slopes varied from steep to gentle. While deciduous trees dominated the community, there a small component of evergreen trees *Picea glauca* (in the Black Hills) and *Pinus ponderosa* could occasionally be found. Common understorey species included *Prunus virginiana*, *Amelanchier alnifolia*, *Ribes* spp., and *Symphoricarpos spp.*. Several authors also documented a *Populus tremuloides / Prunus virginiana* woodland community found in the north-central Great Plains of the United States and Canada Woodland (NatureServe 2003; Faber-Langendoen 2001; Schneider *et al.* 1997). In North Dakota, this community occurred on well-drained loam soils. The canopy was moderately dense to dense and was dominated by *Populus tremuloides*, although *Fraxinus pennsylvanica* may be a common associate. The shrub layer was typically very well developed and was dominated by *Prunus virginiana*. Other understorey species included *Amelanchier alnifolia*, *Corylus spp.*, *Rosa* spp., and *Symphoricarpos occidentalis*. *Aralia nudicaulis*, *Maianthemum stellatum*, and *Galium boreale* may be found in the herbaceous layer. Several authors note a *Populus tremuloides / Amelanchier alnifolia* forest community type (NatureServe 2003; MNHP 2002) and a *Populus tremuloides / Amelanchier alnifolia* / Tall forb community type (NatureServe 2003; Rust 1997) unfortunately no further information is provided for either community.

Numerous other *Populus tremuloides*–dominated community types have been described outside of Alberta, however most do not share many site or floristic characteristics and thus have not been discussed.

Table 38. Similarity rating for *Populus tremuloides / Prunus virginiana - Amelanchier alnifolia / Carex siccata* community types documented outside Alberta.

Similar Communities and Citations	Similarity Rating	Comments
Populus tremuloides sand type (Thorpe and Godwin 1993)	1	This community has quite a similar species composition and similar site conditions.
Populus tremuloides loam type (Thorpe and Godwin 1993)	2	This community has quite a similar species composition though somewhat different site conditions.
Populus tremuloides / Prunus virginiana Forest (NatureServe 2003; MNHP 2002; Faber-Langendoen 2001; Marriott and Faber-Langendoen 2000; Schneider *et al.* 1997)	2	This community has different site characteristics but is quite similar floristically to that found in Wainwright.
Populus tremuloides / Prunus virginiana Woodland (NatureServe 2003; Faber-Langendoen 2001; Schneider *et al.* 1997)	3	This community has different site characteristics and is different floristically than that found in Wainwright.
Populus tremuloides / Amelanchier alnifolia / Tall Forbs (NatureServe 2003; Rust 1997)	?	This community is noted to occur in Idaho, Nevada and Utah. Unfortunately no further information is provided. Due to lack of information, cannot assess similarity.
Populus tremuloides / Amelanchier alnifolia Forest(NatureServe 2003; MNHP 2002)	?	This community is noted to occur in Colorado, Montana and Wyoming, as well as in Ontario. Unfortunately no further information is provided. Due to lack of information, cannot assess similarity.

3.10.2 Preliminary Conservation Ranking of *Populus tremuloides / Prunus virginiana - Amelanchier alnifolia / Carex siccata* Community

Preliminary Rank: ***S3***

This community type was quite common in the Wainwright Dunes Ecological Reserve where it was found on steep, generally northeast facing slopes on the leeward side of dunes. Although the community type occurred in narrow (7-12 metre) strips, it was quite extensive and occurred regularly throughout the landscape.

Communities with a similar, though slightly different, floristic composition are found commonly throughout Alberta and the Aspen Parkland and Great Plains in general (NatureServe 2003; Faber-Langendoen 2001; Marriott and Faber-Langendoen 2000a; Meijer and Karpuk 1999; Schneider *et al.* 1997; Adams *et al.* 1997; Pearson Timberline 1993; Fehr 1982). However, the prominence of Carex siccata does indicate a slightly different community type, likely due to the coarse-textured eolian substrate.

A preliminary rank of **S3** is suggested for this community type, as it appears to be quite widespread and relatively common throughout the Wainwright Dunes Ecological Reserve (i.e. greater than 21 occurrences) but not elsewhere in Alberta. Additional sampling in sand dune and sand plain landscapes outside the Wainwright Dunes Ecological Reserve may help to clarify the status and overall geographic extent of this community type.

3.11 *Populus tremuloides / Amelanchier alnifolia - Rosa acicularis / Poa palustris* Association

Aspen / saskatoon – prickly rose / fowl bluegrass

Plate 9. *Populus tremuloides / Amelanchier alnifolia - Rosa acicularis / Poa palustris* community type (Aspen / saskatoon – prickly rose / fowl bluegrass) Plot 1.

The *Populus tremuloides / Amelanchier alnifolia - Rosa acicularis / Poa palustris* community type was quite extensive in the Ecological Reserve where moisture was available and it is marked by a high diversity of species. *Populus tremuloides* was the dominant overstorey species and common shrub species included *Amelanchier alnifolia*, *Rosa acicularis*, *Cornus stolonifera* and *Symphoricarpos occidentalis*. Shrub cover typically exceeded 70 %. *Poa palustris* cover was also quite high, with other graminoids including *Oryzopsis asperifolia* and *Poa pratensis*. *Thalictrum venulosum* was the dominant forb, with approximately 10 % cover, although *Galium boreale*, *Viola canadensis* and *Lathyrus ochroleucus* were also quite common. Table 39 summarizes the species composition and mean percent cover for this community type.

Table 39. Summary statistics for the *Populus tremuloides / Amelanchier alnifolia - Rosa acicularis / Poa palustris* community type (n = 1).

Species	Mean % Cover
a palustris	50.0
Populus tremuloides	46.0
Amelanchier alnifolia	40.0
Rosa acicularis	30.0
Cornus stolonifera	11.0
Thalictrum venulosum	10.0
Symphoricarpos occidentalis	8.0
Gallium boreale	6.0
Bromus inermis	2.0
Viola canadensis	2.0
Corylus cornuta	1.0
Fragaria virginiana	1.0
Lathyrus ochroleucus	1.0
Oryzopsis asperifolia	1.0
Salix bebbiana	1.0
Aster ciliolatus	0.5
Poa pratensis	0.5
Prunus virginiana	0.5
Smilacina stellata	0.5
Viola adunca	0.5
Ribes oxyacanthoides	0.1

This community was found on generally level sites. A summary of site data is provided in Table 40.

Table 40. Summary of site data for the *Populus tremuloides / Amelanchier alnifolia - Rosa acicularis / Poa palustris* community type (n = 1).

Plot	Elevation	Slope	Aspect	Drainage	Site Position	Surface Shape	Moisture Regime	Nutrient Regime
1	701	1	n/a	Well	Level	Straight	Submesic	Medium

3.11.1 Comparison of *Populus tremuloides / Amelanchier alnifolia - Rosa acicularis / Poa palustris* Community to Literature

Previous studies in the Wainwright Dunes Ecological Reserve and elsewhere in Alberta have identified related community types, which are listed in Table 41. Fehr (1984) described mesic aspen communities during a previous biophysical inventory of the Wainwright Dunes Ecological Reserve. Fehr noted mesic aspen stands, often with a secondary tree canopy layer. Three shrub species formed the tall shrub layer, averaging 25% cover and included *Prunus virginiana, Amelanchier alnifolia* and *Populus tremuloides*. The low shrub layer averaged 85% cover and includes *Corylus cornuta, Rosa acicularis, Amelanchier alnifolia, Cornus stolonifera* and *Rubus strigosus*. A *Populus tremuloides* / (sparse understorey) community was described from the Central Parkland subregion, where it was found on depressional sites as well as gently to moderately sloping sites with a northerly to southerly aspect. The community consists of young (<30 years old) aspen, with little or no understorey growth. While the scrubby aspen community in the sand flats of the Ecological Reserve is quite young, they do tend to have a somewhat developed understorey, at least as far as dwarf-shrub and graminoids are concerned. A *Populus tremuloides / Prunus virginiana* – (Shrub) / Low Herb community has been described from the Central Parkland where it is found several locations. Meijer and Karpuk (1999) described this community from the Dillberry Lake area, where it occurred on upland eolian and glaciofluvial materials, on upper slopes

Table 39. Summary statistics for the *Populus tremuloides / Amelanchier alnifolia - Rosa acicularis / Poa palustris* community type (n = 1).

Species	Mean % Cover
Poa palustris	50.0
Populus tremuloides	60.0
Amelanchier alnifolia	40.0
Rosa acicularis	30.0
Cornus stolonifera	11.0
Thalictrum venulosum	10.0
Symphoricarpos occidentalis	8.0
Galium boreale	6.0
Bromus inermis	2.0
Viola canadensis	2.0
Corylus cornuta	1.0

Species	Mean % Cover
Fragaria virginiana	1.0
Lathyrus ochroleucus	1.0
Oryzopsis asperifolia	1.0
Salix bebbiana	1.0
Aster ciliolatus	0.8
Poa pratensis	0.5
Prunus virginiana	0.5
Smilacina stellata	0.5
Viola adunca	0.5
Ribes oxyacanthoides	0.1

This community was found on generally level sites. A summary of site data is provided in Table 40.

Table 40. Summary of site data for the *Populus tremuloides / Amelanchier alnifolia - Rosa acicularis / Poa palustris* community type (n = 1).

Plot	Elevation	Slope	Aspect	Drainage	Site Position	Surface Shape	Moisture Regime	Nutrient Regime
1	701	1	n/a	Well	Level	Straight	Submesic	Medium

3.11.1 Comparison of *Populus tremuloides / Amelanchier alnifolia - Rosa acicularis / Poa palustris* Community to Literature

Previous studies in the Wainwright Dunes Ecological Reserve and elsewhere in Alberta have identified related community types, which are listed in Table 41. Fehr (1984) described mesic aspen communities during a previous biophysical inventory of the Wainwright Dunes Ecological Reserve. Fehr noted mesic aspen stands, often with a secondary tree canopy layer. Three shrub species formed the tall shrub layer, averaging 25% cover and included *Prunus virginiana*, *Amelanchier alnifolia* and *Populus tremuloides*. The low shrub layer averaged 85% cover and includes *Corylus cornuta*, *Rosa acicularis*, *Amelanchier alnifolia*, *Cornus stolonifera* and *Rubus strigosus*. A *Populus tremuloides* / (sparse understorey) community was described from the Central Parkland subregion, where it was found on depressional sites as well as gently to moderately sloping sites with a northerly to southerly aspect. The community consists of young (<30 years old) aspen, with little or no understorey growth. While the scrubby aspen community in the sand flats of the Ecological Reserve is quite young, they do tend to have a somewhat developed understorey, at least as far as dwarf-shrub and graminoids are concerned. A *Populus tremuloides / Prunus virginiana* – (Shrub) / Low Herb community has been described from the Central Parkland where it is found several locations. Meijer and Karpuk (1999) described this community from the Dillberry Lake area, where it occurred on upland eolian and glaciofluvial materials, on upper slopes where there was little moisture accumulation. Pearson Timberline (1993) noted this community from the Wainwright Dunes area, where it was found on dry sandy outwash plains, dune complexes, depressions and kame moraines. The slope ranged from 0-70%. Other noted species include: *Amelanchier alnifolia, Symphoricarpos occidentalis, Rosa spp., Juniperus horizontalis, Lathyrus ochroleucus, Schizachne purpurescens, Carex foenea, Thermopsis rhombifolia, Smilacina stellata* and *Galium boreale*. Adams *et al.* (1997) described a *Populus tremuloides / Symphoricarpos occidentalis* community dominated by aspen in the overstorey, with *Symphoricarpos occidentalis, Salix spp.*, and *Betula occidentalis* in the shrub understorey. *Agropyron trachycaulum* was noted to be the dominant graminoid. This community was found on a variety of parent materials, but they were dominantly sandy. Slopes ranged up to 10 % but typically had a southeasterly aspect. An aspen / low-bush cranberry community is described for both the Boreal Mixedwood and the foothills regions of Alberta (Beckingham and Archibald 1996; Beckingham *et al.* 1996). This community was typically found on medium textured, mesic soils. Common understorey species included *Viburnum edule, Linnea borealis, Rosa acicularis, Aralia nudicaulis* and *Calamagrostis canadensis*. Adams *et al.* (1997) also noted a general *Populus tremuloides* community type unfortunately no further information was provided. Many other *Populus tremuloides*–dominated community types have been described for Alberta, however most do not share many site or floristic characteristics and thus have not been discussed.

Table 41. Similarity rating for *Populus tremuloides / Amelanchier alnifolia - Rosa acicularis / Poa palustris* community types documented within Alberta.

Similar Communities and Citations	Similarity Rating	Comments
Mesic aspen communities (Fehr 1984)	1	This community is the same in terms of site characteristics, stand structure and species composition.
Populus tremuloides / (sparse understorey) (Wheatley and Bentz 2002; Fehr 1982)	3	This community is somewhat quite distinctly different in site and community composition.
Populus tremuloides / Prunus virginiana – (Shrub) / Low Herb (Meijer and Karpuk 1999; Pearson Timberline 1993; Fehr 1984;)	1	The site characteristics documented in the literature matches the observed sites quite well, and the species composition and stand structure is also very similar.
Populus tremuloides / Symphoricarpos occidentalis (Adams *et al.* 1997)	3	This community is quite different floristically and in site characteristics than that found in the Wainwright area.
Populus tremuloides (Adams *et al.* 1997)	?	There is no information provided regarding the floristic composition and site characteristics of this community as it is considered to be minor or indistinct community that will be further developed with additional field sampling. As such it is difficult to assess its similarity to the community found in Wainwright.
Aspen (Birch) / Blueberry (Beckingham and Archibald 1996)	3	The site characteristics and floristic composition of this community are quite different than those of the Wainwright community.
Aspen / Hairy Wild Rye (Beckingham *et al.* 1996)	3	The site characteristics and floristic composition of this community are quite different than those of the Wainwright community.
Aspen / Low-bush cranberry (Beckingham and Archibald 1996; Beckingham *et al.* 1996)	2	The site characteristics of this community are quite different than those of the Wainwright community, although floristically they are quite similar.

Various related community types have been recorded outside of Alberta, which are listed in Table 42. Thorpe and Godwin (1993) described a *Populus tremuloides* sand type from the Manito Sandhills in Saskatchewan. This community was characterized by aspen forests found on upland, north-facing or lower slope positions as well as on more stabilized landforms. This community was found to be most widespread occurring community type in Manito Sandhills. The authors also documented a *Populus tremuloides* loam type, forests found on well to moderately well drained sandy loam to clay loam soils. Common species included *Symphoricarpos occidentalis, Rubus* *strigosus, Amelanchier alnifolia, Rosa woodsii, Galium boreale, Thalictrum venulosum, Fragaria virginiana* and *Carex siccata*.

Table 42. Similarity rating for *Populus tremuloides / Amelanchier alnifolia - Rosa acicularis / Poa palustris* community types documented outside Alberta.

Similar Communities and Citations	Similarity Rating	Comments
Populus tremuloides sand type (Thorpe and Godwin 1993)	2	This community has quite a similar species composition, though different site conditions.
Populus tremuloides loam type (Thorpe and Godwin 1993)	1	This community has quite a similar species composition though slightly different site conditions.
Populus tremuloides / Prunus virginiana Forest (NatureServe 2003; MNHP 2002; Faber-Langendoen 2001; Marriott and Faber-Langendoen 2000; Schneider *et al.* 1997)	2	This community has different site characteristics but is quite similar floristically to that found in Wainwright.
Populus tremuloides / Prunus virginiana Woodland (NatureServe 2003; Faber-Langendoen 2001; Schneider *et al.* 1997)	2	This community has different site characteristics but is quite similar floristically to that found in Wainwright..
Populus tremuloides / Corylus cornuta Forest (Faber-Langendoen 2001; Marriott and Faber-Langendoen 2000;Schneider *et al.* 1997)	2	This community has different site characteristics but shares several floristic similarities to the Wainwright community

A number of authors documented a *Populus tremuloides / Prunus virginiana* forest community type from the Rocky Mountains and Black Hills in the western United States (NatureServe 2003; Faber-Langendoen 2001; Marriott and Faber-Langendoen 2000a; Schneider *et al.* 1997). In the Black Hills, this community tended to occur along mesic valley bottoms where slopes varied from steep to gentle. While deciduous trees dominated the community, there a small component of evergreen trees *Picea glauca* (in the Black Hills) and *Pinus ponderosa* could occasionally be found. Common understorey species included *Prunus virginiana, Amelanchier alnifolia, Ribes* spp., and *Symphoricarpos spp*. Several authors also documented a *Populus tremuloides / Prunus virginiana* woodland community found in the north-central Great Plains of the United States and Canada Woodland (NatureServe 2003; Faber-Langendoen 2001; Schneider *et al.* 1997). In North Dakota, this community occurred on well-drained loam soils. The canopy was moderately dense to dense and was dominated by *Populus tremuloides*, although *Fraxinus pennsylvanica* may be a common associate. The shrub layer was typically very well developed and was dominated by *Prunus virginiana*. Other understorey species included *Amelanchier alnifolia, Corylus spp., Rosa* spp., and *Symphoricarpos occidentalis. Aralia nudicaulis, Maianthemum stellatum*, and *Galium boreale* may be found in the herbaceous layer. A *Populus tremuloides / Corylus cornuta* forest community type has been described from the midwest, where it is found in gently sloping to rolling topography in the northwest Great Plains and the Rocky Mountains and Black Hills ranges in the U.S. and southern Canada Forest (Faber-Langendoen 2001; Marriott and Faber-Langendoen 2000;Schneider *et al.* 1997). It is thought to extend from Colorado and South Dakota north to Saskatchewan. *Populus tremuloides* was the dominant tree although *Betula papyrifera* was common and may be codominant. Scattered *Quercus macrocarpa, Fraxinus pennsylvanica* and, in the Black Hills, *Picea glauca* or *Pinus ponderosa* occurred. There was a prominent understorey of shrubs and forbs with few graminoids. The shrub layer was dominated by *Corylus cornuta* although *Amelanchier alnifolia, Mahonia repens, Prunus virginiana, Symphoricarpos spp.*, and *Rubus idaeus* may also be associated. In the western part of its range *Spiraea betulifolia* commonly occurred. The herbaceous layer was characterized by *Aralia nudicaulis, Lathyrus ochroleucus, Maianthemum canadense, Galium triflorum, Maianthemum stellatum, Viola spp.*, and *Sanicula marilandica*.

Many other *Populus tremuloides*–dominated community types have been documented outside of Alberta, however most do not share many site or floristic characteristics and thus have not been discussed.

3.11.2 Preliminary Conservation Ranking of *Populus tremuloides / Amelanchier alnifolia - Rosa acicularis / Poa palustris* Community

Preliminary Rank: ***S5***

This community type was quite extensive in the Wainwright Dunes Ecological Reserve and was found on level sites where moisture was available. Communities with a similar floristic composition are common throughout Alberta and the Aspen Parkland and Great Plains in general (NatureServe 2003; Faber-Langendoen 2001; Marriott and Faber-Langendoen 2000a; Meijer and Karpuk 1999; Schneider *et al.* 1997; Adams *et al.* 1997; Pearson Timberline 1993; Fehr 1982). While the communities described from Wainwright occur on a sandy substrate, this is not a restriction to the distribution of this community.

A preliminary rank of **S5** is suggested for this community type, as it appears to be quite extensive.

3.12 *Salix bebbiana / Festuca saximontana* Association

Beaked willow / Rocky Mountain sedge

Plate 10. *Salix bebbiana / Festuca saximontana* community type (Beakedwillow / Rocky Mountain sedge) Plot 30.

The *Salix bebbiana / Festuca saximontana* community type was not common or extensive. It was typically found in depressional locations in sand plains or occasionally in a depressional site between dunes. In all cases, a relatively open shrub cover dominated by *Salix bebbiana* characterized the community. Other shrub species were present, including young *Populus tremuloides* as well as *Juniperus horizontalis* and *Arctostaphylos uva-ursi*. *Festuca saximontana* was the dominant gramnoid, although *Koeleria macrantha* was also found at each site sampled. *Solidago missouriensis* and *Heuchera richardsonii* were also relatively common, as was *Cladina nitis*. Table 43 summarizes the species composition, mean percent cover, standard error and species prominence for this community type.

Table 43. Summary statistics for the *Salix bebbiana / Festuca saximontana* community type (n = 3).

Species	Mean % Cover	Standard Error	Presence	Prominence
Salix bebbiana	12.0	5.7	3	12.0
Festuca saximontana	9.5	7.8	3	9.5
Koeleria macrantha	7.7	3.7	3	7.7
Populus tremuloides	6.3	3.0	3	6.3
Cladina mitis	3.7	1.7	3	3.7
Solidago spathulata	2.0	0.6	3	2.0
Heuchera richardsonii	0.5	0.0	3	0.5
Carex siccata	13.3	10.9	2	16.3
Juncus balticus	6.8	6.6	2	8.4
Juniperus horizontalis	2.0	1.5	2	2.4
Poa pratensis	2.0	1.5	2	2.4
Comandra umbellata	1.8	1.6	2	2.2
Arctostaphylos uva-ursi	1.0	0.6	2	1.2
Artemisia ludoviciana	0.5	0.3	2	0.6
Artemisia campestris	10.0	10.0	1	17.3
Stipa comata	5.0	5.0	1	8.7
Selaginella densa	3.3	3.3	1	5.8
Calamovilfa longifolia	2.3	2.3	1	4.0
Spirea alba	2.3	2.3	1	4.0
Stipa spartea	2.3	2.3	1	4.0
Bouteloua gracilis	1.7	1.7	1	2.9
Carex pensylvanica ssp heliophila	1.7	1.7	1	2.9
Agrostis scabra	0.7	0.7	1	1.2
Schizachne purpurescens	0.7	0.7	1	1.2
Solidago missouriensis	0.7	0.7	1	1.2
Agropyron dasystachyum	0.3	0.3	1	0.6
Amelanchier alnifolia	0.3	0.3	1	0.6
Anemone multifida	0.3	0.3	1	0.6
Carex filifolia	0.3	0.3	1	0.6
Chenopodium pratericola	0.3	0.3	1	0.6
Rosa acicularis	0.3	0.3	1	0.6
Symphoricarpos occidentalis	0.3	0.3	1	0.6
Agoseris glauca	0.2	0.2	1	0.3
Arabis holboellii	0.2	0.2	1	0.3
Artemisia frigida	0.2	0.2	1	0.3
Descurainia sophia	0.2	0.2	1	0.3
Equisetum hymenale	0.2	0.2	1	0.3
Erigeron glabellus	0.2	0.2	1	0.3
Erysimum asperum	0.2	0.2	1	0.3
Gaillardia aristata	0.2	0.2	1	0.3
Gallium boreale	0.2	0.2	1	0.3
Heterotheca villosa	0.2	0.2	1	0.3
Lepidium densiflorum	0.2	0.2	1	0.3
Opuntia fragilis	0.2	0.2	1	0.3
Potentilla hippiana	0.2	0.2	1	0.3
Rosa arkansana	0.2	0.2	1	0.3

This community was typically found in level to slightly depressional sites, with a straight to concave surface shape. The majority of sites had a relatively shallow but extensive accumulation of organic matter at the soils surface, although patches of exposed sand could occasionally be found. A summary of site data is provided in Table 44.

Table 44. Summary of site data for the *Salix bebbiana / Festuca saximontana* community type (n = 3).

Plot	Elevation	Slope	Aspect	Drainage	Site Position	Surface Shape	Moisture Regime	Nutrient Regime
10	693	0	n/a	Well	Toe	Concave	Submesic	Medium
18	670	0	n/a	Well	Level	Straight	Subxeric	Poor
30	686	3	18	Moderately Well	Toe	Straight	Submesic	Medium

3.12.1 Comparison of *Salix bebbiana / Festuca saximontana* Community to Literature

There are few documented communities from Alberta that appear to be related to the community type observed in the Wainwright Dunes Ecological Reserve. A *Salix bebbiana / Cornus stolonifera* community type was reported from throughout the Grassland Natural Region as well as in the Central Parkland, Foothills Parkland, Montane, and Lower Foothills subregions Wainwright (Thompson and Hansen 2002). It was typically found on alluvial terraces with moist to wet soils. *Salix bebbiana* typically formed the tall shrub layer with *Cornus stolonifera* in the understorey. Furthermore, a *Salix bebbiana / Rubus ideaus / Geranium richardsonii* community has been described in the Foothills Parkland subregion where it typically occurred on moderately well to imperfectly drained sites (Allen 2003; Wallis 1980). It was also noted to have a significant tall herb component. Table 45 summarizes the Alberta community types and their similarity to the community found in the Wainwright Dunes Ecological Reserve.

Table 45. Similarity rating for *Salix bebbiana / Festuca saximontana* community types documented within Alberta.

Similar Communities and Citations	Similarity Rating	Comments
Salix bebbiana / Cornus stolonifera (Thompson and Hansen 2002)	3	This community has different site characteristics and a different floristic composition than that found in Wainwright.
Salix bebbiana / Rubus ideaus / Geranium richardsonii (Wallis 1980)	3	This community is very different floristically than that found in Wainwright.

Several related community types have been recorded outside of Alberta, which are listed in Table 46. Hansen *et al.* (1995) described a *Salix bebbiana* community from Montana. This riparian community was documented from alluvial terraces and adjacent to seeps and springs, from low to moderately high elevations in the mountains, mountain valleys and foothills. Common species included: *Poa pratensis, Phleum pratensis, Agrostis stolonifera* and *Solidago canadensis*. Soil textures were quite variable, ranging from clay loam to sandy loam. Another *Salix bebbiana* riparian community has been documented from the Black Hills, where it occurs in both South Dakota and Wyoming (Marriott and Faber-Langendoen 2000). Shrub cover was noted to be somewhat patchy, and some associated species included *Betula occidentalis, Cornus stolonifera, Salix exigua, Symphoricarpos occidentalis,* and *Pentaphylloides floribunda* with quite a variable herbaceous layer.

NatureServe (2003) described a *Salix bebbiana* Temporarily Flooded Shrubland Alliance. This shrubland was found in the montane regions and western plains of the United States, ranging from South Dakota and Montana south to New Mexico. This community was known to be flooded for short periods during the year, usually near low-gradient streams. The water table was well below the soil surface for the majority of the growing season. However, periodically water is at the surface. These communities were typically dominated by a dense growth of shrubs. The most abundant species are *Salix bebbiana, Salix scouleriana,* and *Salix lucida ssp. caudata*. The graminoid and herbaceous layer contained *Scirpus spp., Carex spp., Triglochin palustris, Calamagrostis canadensis,* and *Equisetum* as well as *Gentiana strictiflora, Prunella vulgaris, Pyrola asarifolia, Ranunculus macounii, Sanicula marilandica, Viola canadensis, Vicia americana* and *Zizia aptera*.

Table 46. Similarity rating for *Salix bebbiana / Festuca saximontana* community types documented outside Alberta.

Similar Communities and Citations	Similarity Rating	Comments
Salix bebbiana (Hansen *et al.* 1995)	3	This community is quite different in terms of site characteristics and floristic composition than that found in Wainwright.
Salix bebbiana (Marriott and Faber-Langendoen 2000)	3	This community is quite different in terms of site characteristics and floristic composition than that found in Wainwright.
Salix bebbiana Temporarily Flooded Shrubland Alliance (NatureServe 2003)	3	This community has different floristic and site conditions than that observed at Wainwright.
Salix bebbiana / Mesic Graminoids Shrubland (NatureServe 2003)	? (3)	This community is described as a temporarily flooded deciduous shrubland that is found in Idaho and Utah. Unfortunately, no further information is provided to make an assessment of similarity.
Salix bebbiana Shrubland (MNHP 2002)	? (3)	Listed as G3Q / S3? for Montana. No description given thus no similarity assessment could be made.
Salix bebbiana Shrubland (CNHP 2001)	? (3)	This type is listed as a natural wetland plant community for Colorado, but no description given thus no assessment of similarity could be done. Ranked G3? / S2
Salix bebbiana Shrubland (Rust 1997)	? (3)	Listed as a natural plant community for Idaho. No description given thus no similarity assessment could be made.

NatureServe (2003) also documented a *Salix bebbiana* / Mesic Graminoids Shrubland. This community was described as a temporarily flooded deciduous shrubland that is found in Idaho and Utah community type. Montana, Idaho and Colorado all document *Salix bebbiana* shrublands as native community types, but unfortunately no further information is provided (MNHP 2002; Rust 1997; CNHP 2001).

3.12.2 Preliminary Conservation Ranking of *Salix bebbiana / Festuca saximontana* Community

Preliminary Rank: **SU**

This community was not common or extensive in the Wainwright Dunes Ecological Reserve. It was typically found in depressional locations in sand plains or occasionally in depressional sites between dunes. The majority of the *Salix bebbiana*-dominated communities recorded in the literature were noted to be riparian communities that were temporarily or seasonally flooded. ANHIC (Allen 2003) currently tracks two *Salix bebbiana* communities, however, both are quite different than that found at the Wainwright Dunes Ecological Reserve. This *Salix bebbiana*-dominated community found in the Wainwright Dunes Ecological Reserve may represent a transitional or ecotonal position between other community types. While the three survey plots did share a number of similar prominent plant species, there was substantial variability in the floristic composition of each survey site.

As such a preliminary rank of **SU** is suggested for this community type. Additional sampling from sand dune and sand plain habitats both within the Wainwright Dunes Ecological Reserve and from other areas in Alberta could help to clarify the validity of the community type and determining its geographic extent.

3.13 *Salix petiolaris / Calamagrostis canadensis* Association

Basket willow / bluejoint

Plate 11. *Salix petiolaris / Calamagrostis canadensis* community type (Basket willow / bluejoint) Plot 12.

The *Salix petiolaris / Calamagrostis canadensis* community type formed relatively large units, although their distribution was quite limited. It was typically found in lower landscape positions in sand plains or at the base of large dunes where seasonal drainage provided ephemeral moisture. Tall thickets of *Salix petiolaris* dominated this community, although the occasional *Betula papyrifera* was found in all sample sites. *Cornus stolonifera, Rubus idaeus, Ribes oxyacanthoides* and *Lonicera dioica* were also found at the majority of sites. While forbs did occur, graminoids dominated the ground cover with *Calamagrostis canadensis* being the dominant. *Poa palustris, Poa pratensis* and several species of *Carex* were also found, but with lower percent covers. Common forbs included *Rubus pubescens, Galium triflorum, Cornus canadensis, Epilobium angustifolium* and *Scutellaria galericulata*. Table 47 summarizes the species composition, mean percent cover, standard error and species prominence for this community type.

Table 47. Summary statistics for the *Salix petiolaris / Calamagrostis canadensis* community type (n = 3).

Species	Mean % Cover	Standard Error	Presence	Prominence
Salix petiolaris	58.3	3.2	3	58.3
Calamagrostis canadensis	56.7	3.3	3	56.7
Poa palustris	6.7	1.7	3	6.7
Betula papyrifera	4.0	2.1	3	4.0
Cornus stolonifera	2.8	2.1	3	2.8
Rubus pubescens	2.7	1.2	3	2.7
Gallium triflorum	0.8	0.2	3	0.8
Rubus idaeus	5.3	4.8	2	6.5
Poa pratensis	2.3	1.5	2	2.9
Ribes oxyacanthoides	1.7	1.2	2	2.0
Cornus canadensis	0.8	0.6	2	1.0
Fragaria virginiana	0.7	0.3	2	0.8
Bromus inermis	0.5	0.3	2	0.6
Epilobium angustifolium	0.5	0.3	2	0.6
Scutellaria galericulata	0.5	0.3	2	0.6
Lonicera dioica	0.3	0.2	2	0.4
Viola adunca	0.3	0.2	2	0.4
Viola canadensis	0.3	0.2	2	0.4
Rosa acicularis	3.3	3.3	1	5.8
Schizachne purpurescens	0.7	0.7	1	1.2
Ribes triste	0.5	0.5	1	0.9
Carex spp	0.3	0.3	1	0.6
Populus tremuloides	0.3	0.3	1	0.6
Pyrola asarifolia	0.3	0.3	1	0.6
Symphoricarpos occidentalis	0.3	0.3	1	0.6
Amelanchier alnifolia	0.2	0.2	1	0.3
Prunus virginiana	0.2	0.2	1	0.3

This community was typically found in an imperfectly drained, depressional landscape position. Due to the presence of seepage or ephemeral stream flow, these communities were considered to have a subhygric to hygric moisture regime and a rich (permesotrophic) nutrient regime. A summary of site data is provided in Table 48.

Table 48. Summary of site data for the *Salix petiolaris / Calamagrostis canadensis* community type (n = 2).

Plot	Elevation	Slope	Aspect	Drainage	Site Position	Surface Shape	Moisture Regime	Nutrient Regime
12	682	0	n/a	Imperfectly	Depression	Straight	Hygric	Rich
20	670	0	n/a	Imperfectly	Depression	Straight	Subhygric	Rich
39	682	0	n/a	Imperfectly	Depression	Straight	Subhygric	Rich

3.13.1 Comparison of *Salix petiolaris / Calamagrostis canadensis* Community to Literature

Previous studies in the Wainwright Dunes Ecological Reserve and elsewhere in Alberta have identified related community types, and are summarized in Table 49. Fehr described a "willow community type" in a 1984 survey of the Wainwright Dunes Ecological Reserve. This community was noted to be found in areas with a mesic to subhydric moisture regime that were poorly to imperfectly drained. Tree layers were not commonly found but when they were they had a low percent cover. Tall shrub layer cover averaged about 65% with willow species being dominant. Important willow species included *Salix maccalliana, S. myrtillifolia, S. petiolaris* and *S. planifolia*. *Calamagrostis canadensis* was not noted to be an important graminoid species. While site characteristics are quite similar, the species composition seems somewhat different than those found in this field survey. A *Salix petiolaris* / (low shrubs and herbs) community has been described from two locations in the Central Parkland by different authors (Wheatley and Bentz 2002; Fehr 1982; Wroe 1971). The community was generally found around sloughs, moist depressions and was limited to moist areas with rolling topography. It had been found on sites with mesic to hydric moisture regimes that were typically moderately well to poorly drained. Associated species included *Populus tremuloides, Salix lutea, Populus balsamifera, Rosa woodsii, Amelanchier alnifolia, Poa palustris, Calamagrostis spp. Carex rostrata* and *Carex atherodes*. A *Salix petiolaris – Salix planifolia / Carex utriculata* community was noted to occur around flooded areas near Onoway (Wheatley and Bentz 2002; Griffiths and Griffiths 1987). The community was found in a flooded location, where *Salix pyrifolia* was rare or not found at all. Other species noted to occur included *Carex aquatilis, Glyceria grandis, Scirpus microcarpus, Galium trifidum, Lysmachia thrysiflora, Bidens cernua, Lemna minor* and *Calamagrostis canadensis*. Finally, a *Salix petiolaris / Juncus balticus* community was found in the Central Parkland near Lister Lake. It is described as having a high water table, which limited the establishment of *Populus balsamifera*. Associated species included *Juncus balticus, Calamagrostis stricta*, and *Poa pratensis*.

Table 49. Similarity rating for *Salix petiolaris / Calamagrostis canadensis* community type documented within Alberta.

Similar Communities and Citations	Similarity Rating	Comments
Willow community type (Fehr 1984)	2	While site characteristics are quite similar, the species composition seems somewhat different than those found in this field survey. Fehr may have sampled and included sites that were not visited in this field survey.
Salix petiolaris / (low shrubs and herbs) (Fehr 1982; Wroe 1971)	2	Some of the species in this community are similar to those observed at Wainwright, and generally the site characteristics match as well. However, some of the associated species are significantly different.
Salix petiolaris – Salix planifolia / Carex utriculata (Wheatley and Bentz 2002; Griffiths and Griffiths 1987)	3	While the dominant species in this community is analogous to that found in Wainwright, the site conditions appear to be much wetter. The Wainwright community was found in lowland positions, but along ephemeral drainages.
Salix petiolaris / Juncus balticus (Wheatley and Bentz 2002; Griffiths 1996)	3	This community is substantially different in terms of site characteristics and associated species.

Several related community types have been recorded outside of Alberta and are noted in Table 50. A *Salix petiolaris – (Betula pumila) / Spartina pectinata – Carex lanuginosa* community is described from Manitoba and Minnesota (Schneider *et al.* 1997). Unfortunately, no further information is provided. Furthermore, Schneider *et al.* (1997) described a *Salix petiolaris / Carex interior – Thelypteris palustris* community known to occur from Nebraska and South Dakota, in sandhills habitats.

NatureServe (2003) documented a *Salix petiolaris - (Betula pumila) / Spartina pectinata - Carex pellita* wet brush prairie community type from the aspen parkland region of the upper midwestern United States and Canada, particularly in western Minnesota and southeastern Manitoba. This community typically occurred on level, poorly drained sites with from loamy fine sand to sandy clay loam soils.

Table 50. Similarity rating for *Salix petiolaris / Calamagrostis canadensis* community type documented outside Alberta.

Similar Communities and Citations	Similarity Rating	Comments
Salix petiolaris – (Betula pumila) / Spartina pectinata – Carex lanuginosa (Schneider et al. 1997)	? (3)	No description provided, although it's noted to occur in Manitoba and Minnesota. The authors suggest a conservation rating of G?. No description of community type is given, thus cannot assess similarity. However, superficially it appears to be floristically quite different.
Salix petiolaris / Carex interior – Thelypteris palustris (Schneider et al. 1997)	? (3)	No description provided, although it's noted to occur in Nebraska and South Dakota, in sandhills. The authors suggest a conservation rating of G2. No description of community type is given, thus cannot assess similarity. However, superficially it appears to be floristically quite different though it occurs in sandhills habitats.
Salix petiolaris - (Betula pumila) / Spartina pectinata - Carex pellita Shrubland (NatureServe 2003)	2	This community shares many floristic and site conditions as the community in Wainwright.

The vegetation consisted of clumps or thickets of low shrubs in a graminoid matrix of wet prairie vegetation. Some of the dominant graminoids included *Spartina pectinata*, *Calamagrostis stricta*, *Calamagrostis canadensis*, *Andropogon gerardii*, and *Muhlenbergia richardsonii*. Common sedges included *Carex buxbaumii*, *Carex pellita*, *Carex sartwellii* and *Carex tetanica*. Other shrubs included *Pentaphylloides floribunda)*, *Salix discolor* and *Salix petiolaris*. *Betula pumila* and *Spiraea alba* was occasionally common in certain areas. Scattered saplings, or groves of *Populus tremuloides* and *Populus balsamifera* were noted to occur.

3.13.2 Preliminary Conservation Ranking of *Salix petiolaris / Calamagrostis canadensis* Community

Preliminary Rank: ***SU***

This community type formed relatively large patches in the Wainwright Dunes Ecological Reserve, however it had a limited distribution. It was typically found in lower landscape positions in sand plains or at the base of large dunes where seasonal drainage provided ephemeral moisture. There have been several reports of *Salix petiolaris*-dominated and general *Salix* spp. dominated communities, within Alberta and in other jurisdictions (NatureServe 2003; Schneider *et al. 1997*; Griffiths 1996; Griffiths and Griffiths 1987; Fehr 1982; Wroe 1971). Wheatley and Bentz (2002) assigned a preliminary rank of S5 for *Salix petiolaris* dominated communities in the Central Parkland. However, the floristic composition of all these descriptions vary from that found in the Wainwright Dunes Ecological Reserve. Many of the community descriptions that could be found from within and outside Alberta were too general to provide sufficient information for a conclusive conservation ranking.

As such a preliminary rank of **SU** is suggested for this community type. Additional sampling in sand dune and sand plain habitats outside of the Wainwright Dunes Ecological Reserve may help to clarify the status and geographic extent of this community type.

3.14 *Stipa comata – Artemisia frigida – Selaginella densa* Association

Needle-and-thread – pasture sagewort – prairie selaginella

Plate 12. *Stipa comata – Artemisia frigida - Selaginella densa* community type (Needle-and-thread – pasture sagewort – prairie selaginella) Plot 3.

The *Stipa comata – Artemisia frigida - Selaginella densa* community type was very extensive in the Wainwright Dunes Ecological Reserve, occurring on generally level to gently sloping sand plains. Graminoids were the dominant lifeform, with *Stipa comata* being the most prevalent species. Other common graminoids included *Bouteloua gracilis, Koeleria macrantha, Stipa spartea, Carex siccata*, and *Calamovilfa longifolia*. *Artemisia frigida* was the dominant forb species, although *Selaginella densa, Heterotheca villosa, Artemisia ludoviciana* and *Potentilla hippiana* were also quite common. Several low shrub species were commonly encountered, including *Juniperus horizontalis, Prunus virginiana* and *Rosa arkansana*, although with relatively low percent covers. Table 51 summarizes the species composition, mean percent cover, standard error and species prominence for this community type.

Table 51. Summary statistics for the *Stipa comata – Artemisia frigida - Selaginella densa* community type (n = 4)

Species	Mean % Cover	Standard Error	Presence	Prominence
Stipa comata	28.8	10.3	4	28.8
Artemisia frigida	16.0	5.6	4	16.0
Selaginella densa	10.0	2.0	4	10.0
Bouteloua gracilis	8.8	2.0	4	8.8
Cladina mitis	6.0	1.7	4	6.0
Koeleria macrantha	5.0	0.6	4	5.0
Juniperus horizontalis	4.0	1.0	4	4.0
Heterotheca villosa	1.9	1.0	4	1.9
Stipa spartea	8.0	4.1	3	9.2
Carex siccata	6.3	2.4	3	7.2
Calamovilfa longifolia	5.3	3.4	3	6.1
Artemisia ludoviciana	1.9	1.1	3	2.2
Potentilla hippiana	1.1	0.5	3	1.3
Agoseris glauca	0.7	0.5	3	0.8
Lepidium densiflorum	0.5	0.2	3	0.6
Prunus virginiana	3.5	2.4	2	4.9
Rosa arkansana	1.0	0.7	2	1.4
Anemone patens	0.6	0.3	2	0.8
Erysimum asperum	0.6	0.5	2	0.8
Antennaria parvifolia	0.5	0.6	2	0.7
Geum triflorum	0.5	0.3	2	0.7
Chamaerhodos erecta	0.4	0.2	2	0.5
Comandra umbellata	0.4	0.2	2	0.5
Gaillardia aristata	0.4	0.2	2	0.5
Artemisia campestris	0.3	0.1	2	0.4
Gaura coccinea	0.3	0.1	2	0.4
Descurainia sophia	0.2	0.1	2	0.2
Carex pensylvanica ssp. heliophila	1.3	1.3	1	2.5
Solidago missouriensis	1.3	1.3	1	2.5
Carex filifolia	0.5	0.5	1	1.0
Arctostaphylos uva-ursi	0.3	0.3	1	0.5
Chenopodium pratericola	0.3	0.3	1	0.5
Elymus canadensis	0.3	0.3	1	0.5
Galium boreale	0.3	0.3	1	0.5
Thermopsis rhombifolia	0.3	0.3	1	0.5
Equisetum hyemale	0.1	0.1	1	0.3
Hackelia americana	0.1	0.1	1	0.3
Juncus balticus	0.1	0.1	1	0.3
Poa interior	0.1	0.1	1	0.3
Populus tremuloides	0.1	0.1	1	0.3

This community was typically found on level to gently sloping sand plains that were rapidly drained. Most sites sampled had a shallow but consistent accumulation of organic matter on the soil surface, with typically no greater than 1 % exposed sand at the surface. A summary of site data is provided in Table 52.

Table 52. Summary of site data for the *Stipa comata – Artemisia frigida - Selaginella densa* community type (n = 4).

Plot	Elevation	Slope	Aspect	Drainage	Site Position	Surface Shape	Moisture Regime	Nutrient Regime
3	695	0	n/a	Rapidly	Level	Straight	Xeric	Poor
8	687	3	20	Rapidly	Lower Slope	Straight	Subxeric	Poor
9	696	12	188	Rapidly	Upper Slope	Convex	Subxeric	Poor
40	687	11	196	Well	Middle Slope	Concave	Subxeric	Poor

3.14.1 Comparison of *Stipa comata – Artemisia frigida - Selaginella densa* Community to Literature

Previous studies in the Wainwright Dunes Ecological Reserve and elsewhere in Alberta have identified related community types and these are listed in Table 53. Fehr described a *Calamovilfa longifolia – Artemisia frigida – Koeleria macrantha – Festuca saximontana / Selaginella densa* community type during a 1984 survey (Wheatley and Bentz 2002; Fehr 1984). This community was found in numerous sites typically on xeric to subxeric, rapidly drained sand flats. Dominant species included *Calamovilfa longifolia, Artemisia frigida, Koeleria cristata, Festuca saximontana*, and *Festuca scabrella*. The canopy cover of *Selaginella densa* averaged 28%. The herb-dwarf shrub layer averaged 56%, but could range from 40-70%.

A *Stipa comata – Koeleria macrantha – Agropyron smithii* community type has been described from the Central Parkland subregion, from the Dillberry Lake region (Meijer and Karpuk 1999). This community was found on stabilized dune areas with little sign of current erosion or soil formation. It typically occurred on southwest facing slopes that were rapidly drained and had a subxeric moisture regime. Other species found in this community included *Solidago missouriensis, Thermopsis rhombifolia, Calamovilfa longifolia*, and *Agropyron trachycaulum*. An *Artemisia frigida / Koeleria macrantha – Carex obtusata* community was also described from the same study area (Meijer and Karpuk 1999). While a detailed description of the community is not provided, the authors noted that it was typically found on south facing, glaciofluvial slopes. Its moisture regime was xeric to very xeric, and it was very rapidly drained. Associated species included *Symphoricarpos occidentalis, Heterotheca villosa, Thermopsis rhombifolia* and *Agropyron trachycaulum*. Meijer and Karpuk (1999) also noted a *Stipa comata – Koeleria macrantha – Agropyron trachycaulum – Carex obtusata* community type found on south-facing slopes and flat uplands in hummocky glaciofluvial terrain. Associated species included *Artemisia frigida, Petalostemon purpureum, Heuchera richardsonii, Calamovilfa longifolia, Poa sandbergii* and *Festuca hallii*. This community was noted to be distinguished from similar eolian communities by the presence of *Carex obtusata*.

Adams *et al.* (1997) documented a *Calamovilfa longifolia – Stipa comata – Bouteloua gracilis* community from CFB Suffield. This community was dominated by *Stipa comata* and *Calamovilfa longifolia* with approximately 3% cover of *Artemisia frigida*. There was no mention of the presence of *Selaginella densa*. A number of other *Stipa comata* and *Calamovilfa longifolia* community types were mentioned in this report, but most include the presence of a distinct shrub layer. This community was noted to occur on sandy eolian or glaciofluvial materials with typically less than 5 % slope. A *Bouteloua gracilis – Stipa comata – Calamovilfa longifolia* community was noted from the Pakowki Sandhills region, where it occurs on well-drained sandy, subxeric sites (Komex 1993). It was noted to occur in the vicinity of dune areas and on highly stabilized dunes. Typical associated species included *Koeleria macrantha, Agropyron smithii, Carex spp., Artemisia frigida, Heterotheca villosa*, and *Selaginella densa* among others. A number of authors document a *Koeleria macrantha – Artemisia frigida –Linum lewisii* community that has been found in the Montane subregion (Corns and Achuff 1982; Achuff *et al.* 1986). This community is known to occur on dry, fluvial fans and aprons, morainal erosional scarps and eolian veneers. Sites were typically subxeric to xeric with exposed bare soil at the surface. *Koeleria macrantha, Artemisia frigida, Linum lewisii, Antennaria nitida* and *Gaillardia aristata* are considered to be characteristics species.

Table 53. Similarity rating for *Stipa comata – Artemisia frigida - Selaginella densa* community types documented within Alberta.

Similar Communities and Citations	Similarity Rating	Comments
Calamovilfa longifolia – Artemisia frigida – Koeleria macrantha – Festuca saximontana / Selaginella densa (Wheatley and Bentz 2002; Fehr 1984)	2	While the site characteristics of this community described in the literature matches the sites found in Wainwright during 2003, the species composition is somewhat different.
Stipa comata – Koeleria macrantha – Agropyron smithii (Meijer and Karpuk 1999)	2	While the species composition of this community is somewhat similar to that observed at Wainwright, the site characteristics are notably different.
Artemisia frigida / Koeleria macrantha – Carex obtusata (Meijer and Karpuk 1999)	2	While some species found in this community type occur in the community described from Wainwright, the general composition and site characteristics are quite different.
Stipa comata – Koeleria macrantha – Agropyron trachycaulum – Carex obtusata (Meijer and Karpuk 1999)	2	This community is somewhat similar in floristic composition, however the parent materials and site characteristics are somewhat different.
Bouteloua gracilis – Stipa comata – Calamovilfa longifolia (Komex 1993)	2	While there is some similarity to the floristic composition and site characteristics of this community, the dominant and co-dominant species are notably different.
Calamovilfa longifolia – Stipa comata – Bouteloua gracilis (Adams *et al.* 1997)	2	This community is quite similar to that found in the Wainwright Dunes area with very similar site characteristics. The floristic composition is somewhat different, particularly the lack of *Selaginella densa*.
Koeleria macrantha – Artemisia frigida – Linum lewisii (Corns and Achuff 1982; Achuff *et al.* 1986)	2	This community shares some floristic similarities and site characteristics as the Wainwright community.

Numerous related community types have been recorded outside of Alberta and are listed in Table 54. Thorpe and Godwin (1993) documented an *Artemisia frigida – Bouteloua gracilis – Carex eleocharis – Stipa comata – Koeleria cristata* community from the Manito Sandhills in Saskatchewan. This community was characterized by grasslands on well-drained sandy loam to clay loam soils. Associated species included *Rosa arkansana, Opuntia polycantha, Solidago missouriensis, Thermopsis rhombifolia, Anemone patens* and *Chrysopsis villosa* at low percent covers. There is no mention of *Selaginella densa* being a prominent species. Hulett *et al.* (1966) documented a *Stipa comata – Artemisia frigida* community from the Dundurn Sandhills, in Saskatchewan. This community was noted to be a dominant type that occurred on stabilized dunes. Coupland (1950; 1961) described a *STIPA – BOUTELOUA* faciation from the mixedgrass prairie region of Canada. This association was generally considered to be a climax association and it was noted that *Selaginella densa* was common, typically with at least 7% cover. *Artemisia frigida* was also noted to be common. Looman (1980) also noted a *Stipa comata* association found to be common (with *Bouteloua gracilis*) on dry prairie. The author noted that the cover of *Bouteloua gracilis* increased, gradually replacing *Stipa comata* as grazing increased. A variation of the community included *Calamovilfa longifolia* and occurred on sandy loam or loamy sand soils.

Hanson and Whitman (1938) described a Grama – Needlegrass – Sedge Type from North Dakota where it was found on upland plateaus to gentle upland slopes. Common species included *Bouteloua gracilis, Stipa comata, Carex filifolia, C. stenophylla, Agropyron smithii* and *Koeleria cristata.* NatureServe (2003) described a *Hesperostipa comata - Bouteloua gracilis - Carex filifolia* community type that is thought to be common throughout the northern and central Great Plains of the United States. This community typically occurred on flat to rolling topography with deep sandy loam to loam or coarser-textured soils. Moderate to moderately dense medium-tall grasses typically dominated the vegetation, with *Stipa comata* being the dominant species and *Bouteloua gracilis* and *Carex filifolia* as codominant species.

Table 54. Similarity rating for *Stipa comata – Artemisia frigida - Selaginella densa* community type documented outside Alberta.

Similar Communities and Citations	Similarity Rating	Comments
Artemisia frigida – Bouteloua gracilis – Carex eleochans – Stipa comata – Koeleria cristata (Thorpe and Godwin 1993)	1	This community has a fairly similar species composition and very similar site conditions.
Stipa comata – Artemisia frigida (Hulett *et al.* 1966)	2	The species composition varies somewhat, and site conditions are somewhat different.
STIPA – BOUTELOUA Faciation (Coupland 1961; Coupland 1950)	1	This community has a similar floristic composition and similar site conditions.
Stipa comata ASSOCIATION (Looman 1980)	2	The species composition and site conditions area quite similar.
Grama – Needlegrass – Sedge Type (Hanson and Whitman 1938)	2	The species composition varies somewhat, and site conditions are somewhat different.
Hesperostipa comata - Bouteloua gracilis - Carex filifolia Herbaceous Vegetation (NatureServe 2003)	2	This community is very similar floristically and in terms of site conditions to that observed in Wainwright.
Hesperostipa comata - Bouteloua gracilis - Carex filifolia (USGS 2002; MNHP 2002; Faber-Langendoen 2001; Marriott and Faber-Langendoen 2000; Schneider et al. 1997)	2	This community shares many floristic similarities and matches the site characteristics observed in Wainwright.
Calamovilfa longifolia - Hesperostipa comata Herbaceous Vegetation (Faber-Langendoen 2001)	3	This community shares some floristic similarities but has different site characteristics than that observed in Wainwright.
Hesperostipa comata - Carex filifolia Herbaceous Vegetation (NatureServe 2003)	? (3)	This community is described from Montana where it is given a G4 conservation rating. Unfortunately no further information is provided, making an assessment of similarity difficult.
Stipa comata / Carex filifolia (MNHP 2002; Hansen and Hoffman 1988)	2	This community type shares some floristic similarities and has the same general habitat characteristics as that observed in Wainwright.
Hesperostipa comata - Carex inops ssp. heliophila Herbaceous Vegetation (NatureServe 2003; MNHP 2002)	? (3)	This community is described from Montana and Wyoming where it is given a G4 conservation rating. Unfortunately no further information is provided, making an assessment of similarity difficult.
Stipa comata / Carex heliophila (Schneider *et al.* 1997; Hansen and Hoffman 1988)	2	This community type shares many floristic similarities and has the same general site characteristics as that observed in Wainwright.

Calamovilfa longifolia was often a component on sandier soils, while *Koeleria macrantha* cover increased on degraded sites. Other common species included *Artemisia frigida*, *Gutierrezia sarothrae* and *Rosa arkansana* however their total cover typically did not exceed 5%, except on overgrazed sites. Cover values for forbs were generally low, with the exception of *Selaginella densa*. Faber-Langendoen (2001) documented a *Calamovilfa longifolia - Hesperostipa comata* community type that was found in the central and northern Great Plains region, ranging from Colorado and Nebraska, north to Wyoming and South Dakota. The vegetation had an open canopy and was dominated by mid to tall grasses. *Calamovilfa longifolia* was the most prominent grass although *Bouteloua gracilis*, *Koeleria macrantha*, *Achnatherum hymenoides*, *Sporobolus cryptandrus* and *Hesperostipa comata* were also quite common. Sedges were reported to be uncommon but occasionally included *Carex inops ssp. heliophila*. Forb diversity ranged from low to moderate. *Artemisia frigida, Artemisia ludoviciana, Gutierrezia sarothrae, Psoralidium tenuiflorum*, and *Yucca glauca* were occasionally present. Shrubs occurred infrequently with low covers. This community was most frequently found on stabilized sand dunes, as well as in interdunal valleys or draws. Soils were generally medium to fine sands formed either from eolian or colluvial processes.

A number of sources described a *Hesperostipa comata - Carex filifolia* community generally from the Montana and South Dakota regions (NatureServe 2003; MNHP 2002; Hansen and Hoffman 1988). Hansen and Hoffman documented this community from the Custer National Forest in Montana and South Dakota, where it occurred on level or gently sloping sites with relatively little surface erosion. *Stipa comata, Carex filifolia, Agropyron smithii, Bouteloua gracilis, Artemisia frigida* and *Koeleria macrantha* consistently had the highest covers. Forb cover was notable, but was still exceeded by graminoid cover. The soil textures ranged from loams to loamy sand. A number of sources also described a *Hesperostipa comata - Carex inops ssp. heliophila* community (NatureServe 2003; MNHP 2002; Schneider *et al.* 1997; Hansen and Hoffman 1988). Hansen and Hoffman documented this community from the Custer National Forest in Montana and South Dakota where it occurred on relatively level uplands. *Stipa comata* and *Carex heliophila* were dominant, with *Artemisia ludoviciana, Agropyron smithii, Koeleria macrantha, Stipa viridula, Antennaria rosea, Gaura coccinea, Aster ericoides, Artemisia frigida, Rosa arkansana* and *Petalostemon purpureum* being common species. *Selaginella densa* was typically found in scattered dense mats, with about 16% cover on average. The soil textures ranged from loams to loamy sands.

3.14.2 Preliminary Conservation Ranking of *Stipa comata – Artemisia frigida - Selaginella densa* Community

Preliminary Rank: ***S3S4***

This community type was found extensively in the Wainwright Dunes Ecological Reserve, occurring on generally level to gently sloping sand plains. *Stipa comata* dominated grassland communities, with associated species such as *Artemisia frigida* and *Selaginella densa* are quite extensive and common throughout the Great Plains regions, and the Grassland Natural Region of Alberta. However, this community is rather unique in the sense that many hectares have most likely been converted to agricultural use and also that it is so extensive as far north as it is.

NatureServe (2003) currently ranks a number of *Stipa comata* dominated communities as G4. However, due to the fact that central Alberta is reaching the northern limits of this community type's distribution, it should be ranked with a higher conservation ranking. As such a preliminary rank of **S3S4** is suggested.

4.0 Conclusion

The preliminary analysis of plot data and classification of the sand dune and sand plain plant communities in the Wainwright Dunes Ecological Reserve revealed 12 community types. Community types included all classes, except non-vascular dominated and sparsely vegetated. All proposed community types were described and assigned a suggested preliminary ranking. Cross-reference tables were created to present similar communities described in the literature, rate their similarity with the Wainwright Dunes Ecological Reserve communities and explain their relation to the proposed community types.

Several difficulties were encountered which should be noted. In the literature, community type descriptions vary from a single sentence to extremely detailed descriptions and in most instances, there is insufficient information to adequately describe community structure and assign a conservation rank (i.e. based on distribution and abundance). No quantification of area for community types could be found in the literature, aside from qualitative notes such as 'widely distributed' or 'abundant.' Furthermore, no quantification of the area of community types was required for this project or other similar projects in Alberta (e.g. Coenen and Bentz 2003). As such, determining the areal coverage of community types was done through observation and estimation. Mapping of community types at a relatively detailed scale would provide a greater confidence behind the estimation of conservation ranks for this project and provide a means to track impacts on community types in the future. Additional inventories of sandhill habitats within the subregion would also help greatly to clarify the distribution and quantity of plant community types.

The natural process of succession in sand dunes also poses difficulties in assessing plant communities. While the model for classifying plant communities (Grossman *et al.* 1998) follows an integrated physiognomic and floristic approach, plant community succession is largely overlooked. With respect to active eolian landscapes, changes in habitats and conditions can be observed in a relatively short time period. In several instances, community types noted in the published literature appeared to be somewhat similar to those observed in the Wainwright Dunes Ecological Reserve. However, the prominence of certain species (e.g. lichens, pioneer graminoids, etc.) tends to indicate different successional stages in a community although the habitat / site conditions appear to be virtually identical (e.g. active blowout). Consequently, it likely that several communities identified in the 2003 survey of the Wainwright Dunes Ecological Reserve are quite closely related to communities reported in current literature. However due to the limitations of the classification system these similarities may not be obvious, due to the different prominent species at slightly different successional stages.

The information in this report can be used to update the community-tracking list by including new community types. Finally, this report can also be used to decide which community types require further studies and to prioritize these studies.

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Appendix 1. Glossary of Scientific and Common Plant Species Names

Latin Name	Common Name
Agoseris glauca	false dandelion
Agropyron dasystachyum	northern wheatgrass
Agrostis scabra	rough hair grass
Amelanchier alnifolia	saskatoon
Anemone multifida	cut-leaf anemone
Anemone patens	prairie crocus
Antennaria parvifolia	small-leaved everlasting
Arabis holboellii	reflexed rock cress
Aralia nudicaulis	wild sarsaparilla
Arctostaphylos uva-ursi	common bearberry
Artemisia campestris	plains wormwood
Artemisia frigida	pasture sagewort
Artemisia ludoviciana	prairie sagewort
Aster ciliolatus	Lindley's aster
Betula occidentalis	water birch
Betula papyrifera	white birch
Bouteloua gracilis	blue grama
Bromus inermis	awnless brome
Calamagrostis canadensis	bluejoint
Calamovilfa longifolia	sand grass
Carex filifolia	thread-leaved sedge
Carex pensylvanica ssp. heliophila	sun-loving sedge
Carex siccata	hay sedge
Carex spp.	sedge
Chamaerhodos erecta	chamaerhodos
Chenopodium album	lamb's quarters
Chenopodium leptophyllum	narrow-leaved goosefoot
Chenopodium pratericola	goosefoot
Cladina mitis	reindeer lichen
Cladonia uncialis	lichen
Comandra umbellata	bastard toadflax
Cornus canadensis	bunchberry
Cornus stolonifera	red-osier dogwood
Corylus cornuta	beaked hazelnut
Descurainia sophia	flixweed
Disporum trachycarpum	fairy bells
Elaeagnus commutata	silverberry
Elymus candensis	Canada wild rye
Epilobium angustifolium	common fireweed
Equisetum hymenale	common scouring rush
Erigeron glabellus	smooth fleabane
Erysimum asperum	prairie rocket
Festuca hallii	plains rough fescue
Festuca saximontana	Rocky Mountain fescue
Fragaria virginiana	wild strawberry
Gaillardia aristata	gaillardia

Latin Name	Common Name
Gallium boreale	northern bedstraw
Gallium triflorum	sweet-scented bedstraw
Gaura coccinea	scarlet butterflyweed
Geum triflorum	three-flowered avens
Hackelia americana	nodding stickseed
Helianthus annuus	common annual sunflower
Heliotrichon hookeri	Hooker's oat grass
Heterotheca villosa	golden aster
Heuchera richardsonii	Richardson's alumroot
Juncus balticus	wire rush
Juniperus communis	ground juniper
Juniperus horizontalis	creeping juniper
Kochia scoparia	summer cypress
Koeleria macrantha	June grass
Lathyrus ochroleucus	cream-coloured vetchling
Lepidium densiflorum	common pepper-grass
Linnea borealis	twinflower
Lonicera dioica	twining honeysuckle
Maianthemum candense	wild lily-of-the-valley
Opuntia fragilis	brittle prickly-pear
Oryzopsis asperifolia	white-grained mountain rice grass
Poa interior	inland bluegrass
Poa palustris	fowl bluegrass
Poa pratensis	Kentucky bluegrass
Populus balsamifera	balsam poplar
Populus tremuloides	aspen
Potentilla hippiana	wooly cinquefoil
Prunus virginiana	choke cherry
Pyrola asarifolia	common pink wintergreen
Rhus radicans	poison ivy
Ribes oxyacanthoides	northern gooseberry
Ribes triste	wild red currant
Rosa acicularis	prickly rose
Rosa arkansana	prairie rose
Rubus idaeus	wild red raspberry
Rubus pubescens	dewberry
Salix bebbiana	beaked willow
Salix petiolaris	basket willow
Sanicula marilandica	snakeroot
Schizachne purpurescens	purple oat grass
Scutellaria galericulata	marsh scullcap
Selaginella densa	prairie selaginella
Shepherdia candensis	Canada buffalo berry
Silene drummondii	Drummond's cockle
Smilacina stellata	star-flowered Solomon's-seal
Solidago candensis	Canada goldenrod

Latin Name	Common Name
Solidago missouriensis	low goldenrod
Solidago spathulata	mountain goldenrod
Spirea alba	narrow-leaved meadowsweet
Sporobolus cryptandrus	sand dropseed
Stipa comata	needle and thread
Stipa spartea	porcupine grass
Symphoricarpos albus	snowberry
Symphoricarpos occidentalis	buckbrush
Thalictrum venulosum	veiny meadow rue
Thermopsis rhombifolia	golden bean
Viburnum opulus	high-bush cranberry
Viola adunca	early blue violet
Viola canadensis	western Canada violet

Common Name	Latin Name
aspen	*Populus tremuloides*
awnless brome	*Bromus inermis*
balsam poplar	*Populus balsamifera*
basket willow	*Salix petiolaris*
bastard toadflax	*Comandra umbellata*
beaked hazelnut	*Corylus cornuta*
beaked willow	*Salix bebbiana*
blue grama	*Bouteloua gracilis*
bluejoint	*Calamagrostis canadensis*
brittle prickly-pear	*Opuntia fragilis*
buckbrush	*Symphoricarpos occidentalis*
bunchberry	*Cornus canadensis*
Canada buffalo berry	*Shepherdia candensis*
Canada goldenrod	*Solidago candensis*
Canada wild rye	*Elymus candensis*
chamaerhodos	*Chamaerhodos erecta*
choke cherry	*Prunus virginiana*
common annual sunflower	*Helianthus annuus*
common bearberry	*Arctostaphylos uva-ursi*
common fireweed	*Epilobium angustifolium*
common pepper-grass	*Lepidium densiflorum*
common pink wintergreen	*Pyrola asarifolia*
common scouring rush	*Equisetum hymenale*
cream-coloured vetchling	*Lathyrus ochroleucus*
creeping juniper	*Juniperus horizontalis*
cut-leaf anemone	*Anemone multifida*
dewberry	*Rubus pubescens*
Drummond's cockle	*Silene drummondii*
early blue violet	*Viola adunca*
fairy bells	*Disporum trachycarpum*
false dandelion	*Agoseris glauca*
flixweed	*Descurainia sophia*
fowl bluegrass	*Poa palustris*
gaillardia	*Gaillardia aristata*
golden aster	*Heterotheca villosa*
golden bean	*Thermopsis rhombifolia*
goosefoot	*Chenopodium pratericola*
ground juniper	*Juniperus communis*
hay sedge	*Carex siccata*
high-bush cranberry	*Viburnum opulus*
Hooker's oat grass	*Heliotrichon hookeri*
inland bluegrass	*Poa interior*
June grass	*Koeleria macrantha*
Kentucky bluegrass	*Poa pratensis*
lamb's quarters	*Chenopodium album*
lichen	*Cladonia uncialis*

Common Name	Latin Name
Lindley's aster	*Aster ciliolatus*
low goldenrod	*Solidago missouriensis*
marsh scullcap	*Scutellaria galericulata*
mountain goldenrod	*Solidago spathulata*
narrow-leaved goosefoot	*Chenopodium leptophyllum*
narrow-leaved meadowsweet	*Spirea alba*
needle and thread	*Stipa comata*
nodding stickseed	*Hackelia americana*
northern bedstraw	*Gallium boreale*
northern gooseberry	*Ribes oxyacanthoides*
northern wheatgrass	*Agropyron dasystachyum*
pasture sagewort	*Artemisia frigida*
plains rough fescue	*Festuca hallii*
plains wormwood	*Artemisia campestris*
poison ivy	*Rhus radicans*
porcupine grass	*Stipa spartea*
prairie crocus	*Anemone patens*
prairie rocket	*Erysimum asperum*
prairie rose	*Rosa arkansana*
prairie sagewort	*Artemisia ludoviciana*
prairie selaginella	*Selaginella densa*
prickly rose	*Rosa acicularis*
purple oat grass	*Schizachne purpurescens*
red-osier dogwood	*Cornus stolonifera*
reflexed rock cress	*Arabis holboellii*
reindeer lichen	*Cladina mitis*
Richardson's alumroot	*Heuchera richardsonii*
Rocky Mountain fescue	*Festuca saximontana*
rough hair grass	*Agrostis scabra*
sand dropseed	*Sporobolus cryptandrus*
sand grass	*Calamovilfa longifolia*
saskatoon	*Amelanchier alnifolia*
scarlet butterflyweed	*Gaura coccinea*
sedge	*Carex spp.*
silverberry	*Elaeagnus commutata*
small-leaved everlasting	*Antennaria parvifolia*
smooth fleabane	*Erigeron glabellus*
snakeroot	*Sanicula marilandica*
snowberry	*Symphoricarpos albus*
star-flowered Solomon's-seal	*Smilacina stellata*
summer cypress	*Kochia scoparia*
sun-loving sedge	*Carex pensylvanica ssp. heliophila*
sweet-scented bedstraw	*Gallium triflorum*
thread-leaved sedge	*Carex filifolia*
three-flowered avens	*Geum triflorum*
twinflower	*Linnea borealis*

Common Name	Latin Name
twining honeysuckle	*Lonicera dioica*
veiny meadow rue	*Thalictrum venulosum*
water birch	*Betula occidentalis*
western Canada violet	*Viola canadensis*
white birch	*Betula papyrifera*
white-grained mountain rice grass	*Oryzopsis asperifolia*
wild lily-of-the-valley	*Maianthemum candense*
wild red currant	*Rives triste*
wild red raspberry	*Rubus idaeus*
wild sarsaparilla	*Aralia nudicaulis*
wild strawberry	*Fragaria virginiana*
wire rush	*Juncus balticus*
wooly cinquefoil	*Potentilla hippiana*

Appendix 2. PC-ORD Output from Detrended Correspondence Analysis of Plot Data

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****************** Detrended Correspondence Analysis (DCA) ******************
PC-ORD, Version 4.27
30 Oct 2003, 10:25
Test
Number of non-zero data items:      810
Downweighting selected.  Weights applied to columns, in sequential order:
 0.878 0.523 1.000 0.908 0.785 0.675 0.288 0.935 0.558 1.000
 0.476 1.000 1.000 1.000 0.771 0.509 1.000 0.761 0.780 1.000
 1.000 1.000 1.000 0.471 1.000 0.884 0.621 1.000 1.000 1.000
 0.918 0.385 0.821 0.485 1.000 0.621 0.709 0.684 0.761 1.000
 1.000 1.000 0.986 1.000 1.000 1.000 1.000 0.942 1.000 0.523
 0.471 0.540 0.442 1.000 1.000 0.567 0.698 1.000 0.471 1.000
 1.000 1.000 0.471 0.828 0.471 0.471 1.000 0.698 0.575 1.000
 0.527 1.000 0.905 1.000 0.727 0.776 0.419 1.000 1.000 0.357
 0.998 1.000 0.780 0.362 1.000 0.471 1.000 0.283 0.523 1.000
 0.471 1.000 1.000 1.000 1.000 1.000 1.000 0.883 1.000 0.620
 1.000 0.362 0.303 1.000 1.000

Axes are rescaled
Number of segments: 30
Threshold:  0.00

Total variance ("inertia") in the species data:   5.3428

                   ---------- Axis 1 ----------
 0.2084986269 = residual at iteration   0
 0.0484788418 = residual at iteration   1
 0.0028454519 = residual at iteration   2
 0.0002573977 = residual at iteration   3
 0.0000184850 = residual at iteration   4
 0.0000018544 = residual at iteration   5
 0.0000001855 = residual at iteration   6
 0.2000803500 = residual at iteration   7
 0.1048777625 = residual at iteration   8
 0.0104386704 = residual at iteration   9
 0.0008750346 = residual at iteration  10
 0.0000822394 = residual at iteration  11
 0.0000069755 = residual at iteration  12
 0.0000006538 = residual at iteration  13
 0.0000000994 = residual at iteration  14
 0.8859433532 = eigenvalue

Length of gradient:     4.695
Length of segments:  0.45  0.43  0.40  0.36  0.30  0.25  0.21  0.19  0.18  0.19
Length of segments:  0.19  0.20  0.20  0.20  0.15  0.09  0.08  0.08  0.08  0.08
Length of segments:  0.09  0.10  0.10  0.11
Length of gradient:     6.352

Length of gradient:     7.305
Length of segments:  0.23  0.23  0.23  0.22  0.22  0.21  0.20  0.19  0.19  0.19
Length of segments:  0.19  0.19  0.19  0.19  0.19  0.20  0.20  0.19  0.19  0.19
Length of segments:  0.19  0.18  0.19  0.19  0.20  0.21  0.22  0.23  0.24  0.21
Length of segments:  0.16  0.16  0.16  0.17  0.18  0.20  0.20
Length of gradient:     7.360

                   ---------- Axis 2 ----------
 0.1812712550 = residual at iteration   0
 0.0220914651 = residual at iteration   1
 0.0034740719 = residual at iteration   2
 0.0004910100 = residual at iteration   3
 0.0000816786 = residual at iteration   4
 0.0000119713 = residual at iteration   5
 0.0000020107 = residual at iteration   6
 0.0000002945 = residual at iteration   7
 0.0000000631 = residual at iteration   8
 0.4167989194 = eigenvalue

Length of gradient:     2.669
Length of segments:  0.25  0.26  0.28  0.29  0.29  0.27  0.22  0.16  0.13  0.11
Length of segments:  0.11  0.10  0.10  0.10
Length of gradient:     3.449

Length of gradient:     3.477
Length of segments:  0.18  0.18  0.17  0.18  0.18  0.20  0.22  0.25  0.25  0.23
Length of segments:  0.21  0.19  0.18  0.17  0.16  0.16  0.17  0.19
Length of gradient:     3.459

                   ---------- Axis 3 ----------
 0.0595666654 = residual at iteration   0
 0.0442739502 = residual at iteration   1
 0.0037337963 = residual at iteration   2
 0.0001126581 = residual at iteration    3
 0.0000071591 = residual at iteration    4
 0.0000002313 = residual at iteration    5
 0.0000000746 = residual at iteration    6
 0.2425355464 = eigenvalue

Length of gradient:      2.484
Length of segments:   0.19  0.21  0.24  0.26  0.26  0.26  0.23  0.19  0.16  0.14
Length of segments:   0.13  0.11  0.10
Length of gradient:      2.765

Length of gradient:      2.788
Length of segments:   0.19  0.20  0.20  0.20  0.20  0.21  0.22  0.22  0.21  0.20
Length of segments:   0.19  0.18  0.18  0.18
Length of gradient:      2.770


Test
SPECIES SCORES                          |                          |
    N     NAME      AX1  AX2  AX3       |        RANKED 1          |        RANKED 2
                                        |       EIG=0.886          |       EIG=0.417       |
                                        |                          |                       |
    1 AGOSGLA6       36  -33  284       |   16 BETUPAP    757      |   52 HELIANN6   404    |
    2 AGRODAS7       92    5  393       |   19 CALACAN7   754      |   95 SPORCRY7   402    |
    3 AGROSCA7      196   35    4       |   86 SCUTGAL6   752      |   28 CHENLEP6   318    |
    4 AMELALN       399   75  -20       |   83 SALIPET    751      |   20 CALALON7   315    |
    5 ANEMMUL6      133   46  100       |   32 CORNCAN6   725      |   15 BETUOCC    306    |
    6 ANEMPAT6      -49 -114  229       |   48 GALITRI6   710      |   38 ELYMCAN7   305    |
    7 ANTEPAR6      -29  -71  238       |   77 RIBETRI    709      |   24 CAREX7     298    |
    8 ARABHOL6       55   57   80       |   80 RUBUIDA    700      |   59 KOCHSCO6   297    |
    9 ARALNUD6      505  148  228       |   81 RUBUPUB6   671      |   91 SOLICAN6   288    |
   10 ARCTUVA5      153  285  160       |   75 PYROASA6   656      |   39 EPILANG6   286    |
   11 ARTECAM6       23   23  281       |   45 FRAGVIR6   644      |   10 ARCTUVA5   285    |
   12 ARTEFRI6      -30  -55  171       |   76 RIBEOXY    638      |   22 CAREPEN7   285    |
   13 ARTELUD6       41   17  222       |   18 BROMINE7   632      |   67 ORYZASP7   252    |
   14 ASTECIL6      420  113  192       |   39 EPILANG6   616      |   85 SCHIPUR7   244    |
   15 BETUOCC       277  306  325       |   24 CAREX7     596      |   45 FRAGVIR6   237    |
   16 BETUPAP       757  134  128       |   33 CORNSTO    594      |   23 CARESIC7   232    |
   17 BOUTGRA7        2  -59  241       |   69 POAPAL7    582      |   57 JUNICOM5   232    |
   18 BROMINE7      632  116   33       |  103 VIBUOPU4   537      |   25 CETRUNC9   225    |
   19 CALACAN7      754  135  136       |  105 VIOLCAN6   523      |   26 CHAMERE6   225    |
   20 CALALON7        1  315   35       |   34 CORYCOR    519      |   29 CHENPRA6   212    |
   21 CAREFIL7       -9  133  226       |   71 POPUBAL    512      |   58 JUNIHOR5   207    |
   22 CAREPEN7       89  285  180       |    9 ARALNUD6   505      |   43 FESTHAL7   197    |
   23 CARESIC7      181  232   39       |   63 LINNBOR5   502      |   70 POAPRA7    182    |
   24 CAREX7        596  298  336       |   84 SANIMAR6   494      |   76 RIBEOXY    180    |
   25 CETRUNC9       63  225  200       |   64 LONIDIO    490      |  104 VIOLADU6   179    |
   26 CHAMERE6      -10  225   -4       |   88 SHEPCAN    488      |   44 FESTSAX7   177    |
   27 CHENALB6      143   44   71       |  100 THALVEN6   465      |   88 SHEPCAN    176    |
   28 CHENLEP6       97  318   89       |  104 VIOLADU6   459      |   69 POAPAL7    174    |
   29 CHENPRA6       55  212   89       |   78 ROSAACI    455      |   89 SILEDRU6   171    |
   30 CLADMIT9       76   92  254       |   36 DISPTRA6   438      |   84 SANIMAR6   170    |
   31 COMAUMB6      181   30  358       |   99 SYMPOCC    430      |   63 LINNBOR5   163    |
   32 CORNCAN6      725  135  137       |   14 ASTECIL6   420      |   71 POPUBAL    153    |
   33 CORNSTO       594  136  112       |   65 MAIACAN7   411      |   34 CORYCOR    148    |
   34 CORYCOR       519  148  191       |   61 LATHOCH6   404      |    9 ARALNUD6   148    |
   35 DESCSOP6      149   64   87       |   90 SMILSTE6   403      |   94 SPIRALB    145    |
   36 DISPTRA6      438   84  124       |    4 AMELALN    399      |   61 LATHOCH6   145    |
   37 ELAECOM       162    2 -209       |   70 POAPRA7    394      |   75 PYROASA6   143    |
   38 ELYMCAN7      237  305   54       |   85 SCHIPUR7   392      |   77 RIBETRI    143    |
   39 EPILANG6      616  286  317       |   47 GALIBOR6   358      |   48 GALITRI6   142    |
   40 EQUIHYE6      127  121  -35       |   98 SYMPALB    358      |   81 RUBUPUB6   141    |
   41 ERIGGLA6      248   80  297       |  102 RHUSRYD5   357      |   86 SCUTGAL6   138    |
   42 ERYSASP6        0   89   86       |   67 ORYZASP7   351      |  103 VIBUOPU4   138    |
   43 FESTHAL7      169  197   20       |   91 SOLICAN6   349      |   33 CORNSTO    136    |
   44 FESTSAX7      187  177  289       |   72 POPUTRE    319      |   83 SALIPET    136    |
   45 FRAGVIR6      644  237  248       |   82 SALIBEB    314      |   32 CORNCAN6   135    |
   46 GAILARI6       -3  -41  290       |   94 SPIRALB    277      |   19 CALACAN7   135    |
   47 GALIBOR6      358   76   20       |   15 BETUOCC    277      |   80 RUBUIDA    135    |
   48 GALITRI6      710  142  193       |   57 JUNICOM5   253      |   16 BETUPAP    134    |
   49 GAURCOC6       -9   53  -36       |   74 PRUNVIR    250      |   21 CAREFIL7   133    |
   50 GEUMTRI6      -57 -137  216       |   41 ERIGGLA6   248      |  100 THALVEN6   129    |
   51 HACKAME6       23  -14  -66       |   38 ELYMCAN7   237      |   64 LONIDIO    127    |
   52 HELIANN6      -56  404  -16       |   55 HEUCRIC6   227      |   40 EQUIHYE6   121    |
   53 HELIHOO7        3   41  264       |    3 AGROSCA7   196      |   18 BROMINE7   116    |
   54 HETEVIL6       25   64   57       |  101 THERRHO6   190      |   72 POPUTRE    115    |
   55 HEUCRIC6      227   46  295       |   44 FESTSAX7   187      |   14 ASTECIL6   113    |
   56 JUNCBAL7      157   51  433       |   23 CARESIC7   181      |   78 ROSAACI    104    |
   57 JUNICOM5      253  232  200       |   31 COMAUMB6   181      |   93 SOLISPA6   100    |
   58 JUNIHOR5      151  207  133       |   43 FESTHAL7   169      |  105 VIOLCAN6    99    |
   59 KOCHSCO6        5  297   21       |   37 ELAECOM    162      |   30 CLADMIT9    92    |
   60 KOELMAC7       73   51  219       |   92 SOLIMIS6   162      |   42 ERYSASP6    89    |
  61 LATHOCH6    404   145    23        56 JUNCBAL7    157        65 MAIACAN7     88
  62 LEPIDEN6    112   -41     6        10 ARCTUVA5    153        36 DISPTRA6     84
  63 LINNBOR5    502   163   257        58 JUNIHOR5    151        90 SMILSTE6     83
  64 LONIDIO     490   127    68        35 DESCSOP6    149        82 SALIBEB      82
  65 MAIACAN7    411    88   -35        27 CHENALB6    143        41 ERIGGLA6     80
  66 OPUNFRA6      6    62   265         5 ANEMMUL6    133        47 GALIBOR6     76
  67 ORYZASP7    351   252   235        40 EQUIHYE6    127         4 AMELALN      75
  68 POAINT7      96    63   125        93 SOLISPA6    124       102 RHUSRYD5     72
  69 POAPAL7     582   174   137        62 LEPIDEN6    112        99 SYMPOCC      71
  70 POAPRA7     394   182   248        28 CHENLEP6     97       101 THERRHO6     67
  71 POPUBAL     512   153   221        68 POAINT7      96        98 SYMPALB      66
  72 POPUTRE     319   115    37         2 AGRODAS7     92        35 DESCSOP6     64
  73 POTEHIP6    -28  -108   268        22 CAREPEN7     89        54 HETEVIL6     64
  74 PRUNVIR     250    44   -68        30 CLADMIT9     76        68 POAINT7      63
  75 PYROASA6    656   143   177        60 KOELMAC7     73        66 OPUNFRA6     62
  76 RIBEOXY     638   180   260        25 CETRUNC9     63        92 SOLIMIS6     61
  77 RIBETRI     709   143   207         8 ARABHOL6     55         8 ARABHOL6     57
  78 ROSAACI     455   104    42        29 CHENPRA6     55        49 GAURCOC6     53
  79 ROSAARK5     42     0    52        89 SILEDRU6     49        60 KOELMAC7     51
  80 RUBUIDA     700   135   151        97 STIPSPA7     48        56 JUNCBAL7     51
  81 RUBUPUB6    671   141   159        79 ROSAARK5     42         5 ANEMMUL6     46
  82 SALIBEB     314    82   371        13 ARTELUD6     41        55 HEUCRIC6     46
  83 SALIPET     751   136   137         1 AGOSGLA6     36        74 PRUNVIR      44
  84 SANIMAR6    494   170   274        54 HETEVIL6     25        27 CHENALB6     44
  85 SCHIPUR7    392   244   262        51 HACKAME6     23        53 HELIHOO7     41
  86 SCUTGAL6    752   138   145        11 ARTECAM6     23         3 AGROSCA7     35
  87 SELADEN6     22    -3   160        87 SELADEN6     22        31 COMAUMB6     30
  88 SHEPCAN     488   176   285        66 OPUNFRA6      6        11 ARTECAM6     23
  89 SILEDRU6     49   171   -49        59 KOCHSCO6      5        13 ARTELUD6     17
  90 SMILSTE6    403    83    34        53 HELIHOO7      3         2 AGRODAS7      5
  91 SOLICAN6    349   288   316        17 BOUTGRA7      2        37 ELAECOM       2
  92 SOLIMIS6    162    61   194        20 CALALON7      1        79 ROSAARK5      0
  93 SOLISPA6    124   100   294        42 ERYSASP6      0        87 SELADEN6     -3
  94 SPIRALB     277   145   268        46 GAILARI6     -3        96 STIPCOM7     -6
  95 SPORCRY7    -69   402    -5        21 CAREFIL7     -9        51 HACKAME6    -14
  96 STIPCOM7    -24    -6   176        49 GAURCOC6     -9         1 AGOSGLA6    -33
  97 STIPSPA7     48   -60   248        26 CHAMERE6    -10        46 GAILARI6    -41
  98 SYMPALB     358    66   -46        96 STIPCOM7    -24        62 LEPIDEN6    -41
  99 SYMPOCC     430    71    27        73 POTEHIP6    -28        12 ARTEFRI6    -55
 100 THALVEN6    465   129   140         7 ANTEPAR6    -29        17 BOUTGRA7    -59
 101 THERRHO6    190    67   108        12 ARTEFRI6    -30        97 STIPSPA7    -60
 102 RHUSRYD5    357    72    24         6 ANEMPAT6    -49         7 ANTEPAR6    -71
 103 VIBUOPU4    537   138    82        52 HELIANN6    -56        73 POTEHIP6   -108
 104 VIOLADU6    459   179   120        50 GEUMTRI6    -57         6 ANEMPAT6   -114
 105 VIOLCAN6    523    99    24        95 SPORCRY7    -69        50 GEUMTRI6   -137


Test
SAMPLE SCORES - WHICH ARE WEIGHTED MEAN SPECIES SCORES
    N     NAME        AX1   AX2   AX3          RANKED 1                      RANKED 2
                                              EIG=0.886                     EIG=0.417
    1 P01             433   114    53       20 P20          735         21 P21           345
    2 P02             240   171    81       12 P12          734         19 P19           293
    3 P03              15     0   187       39 P39          682         14 P14           279
    4 P04             517   138   152        4 P04          517         28 P28           250
    5 P05             468   137   184        5 P05          468         27 P27           242
    6 P06             225   185    65        1 P01          433         34 P34           231
    7 P07              84    83   139       25 P25          345         13 P13           220
    8 P08              64    36   182       27 P27          333         35 P35           208
    9 P09              24    63   147       29 P29          322         38 P38           202
   10 P10             150    66   277       36 P36          294          6 P06           185
   11 P11             262   154    74       23 P23          290         17 P17           173
   12 P12             734   139   141       11 P11          262          2 P02           171
   13 P13              81   220   109        2 P02          240         37 P37           170
   14 P14              22   279    67       30 P30          231         23 P23           160
   15 P15              82   115   125        6 P06          225         30 P30           160
   16 P16              80   129   123       37 P37          212         11 P11           154
   17 P17             160   173   105       35 P35          173         39 P39           140
   18 P18              50    77   177       24 P24          171         12 P12           139
   19 P19              25   293    50       34 P34          166          4 P04           138
   20 P20             735   137   136       31 P31          163          5 P05           137
   21 P21               0   345    15       17 P17          160         20 P20           137
   22 P22              66   113   151       10 P10          150         16 P16           129
   23 P23             290   160   114       38 P38          114         32 P32           126
   24 P24             171    91    80       33 P33          106         36 P36           124
   25 P25             345   102    21       32 P32           95         15 P15           115
   26 P26              74    85   169        7 P07           84          1 P01           114
   27 P27             333   242   253       15 P15           82         22 P22           113
   28 P28              75   250    45       13 P13           81         25 P25           102
   29 P29             322    92    19       16 P16           80         29 P29            92
   30 P30             231   160   183       28 P28           75         24 P24            91
   31 P31          163   79    0   |   26 P26         74  |   26 P26         85 |
   32 P32           95  126  127   |   22 P22         66  |    7 P07         83 |
   33 P33          106   74   61   |    8 P08         64  |   31 P31         79 |
   34 P34          166  231  185   |   18 P18         50  |   18 P18         77 |
   35 P35          173  208  191   |   40 P40         37  |   33 P33         74 |
   36 P36          294  124   36   |   19 P19         25  |   10 P10         66 |
   37 P37          212  170  108   |    9 P09         24  |    9 P09         63 |
   38 P38          114  202  142   |   14 P14         22  |    8 P08         36 |
   39 P39          682  140  138   |    3 P03         15  |   40 P40         26 |
   40 P40           37   26  145   |   21 P21          0  |    3 P03          0 |
**************************** Calculations finished ****************************
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